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The high-end GPU that dreams are made of **PG. 74**

GET READY FOR 8K
The next big thing in screens is coming **PG. 38**

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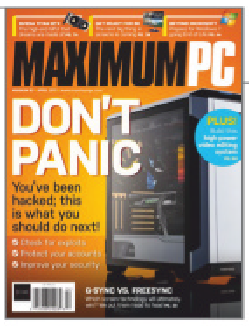

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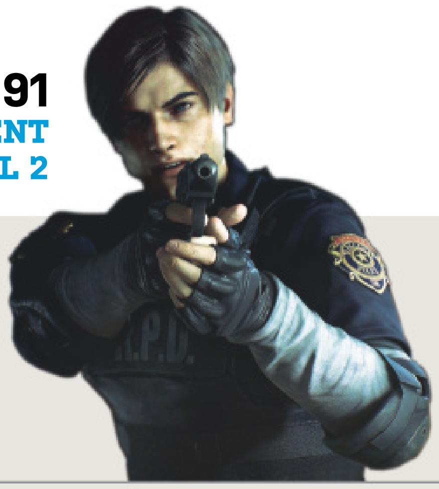

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Alan
Dexter

SECURITY MAY NOT BE SEXY, BUT IT'S WORTH PAYING ATTENTION TO

SECURITY, LIKE BACKING UP, is one of those topics that we all should probably take more seriously than we do. Whenever reports are released highlighting popular password selections, it's clear that not everyone is on the same page, or even reading from the same book. But whether you have strong passwords or not, your accounts can still be compromised, and then you've got to ask yourself what you're going to do about it.

This month's cover feature came about after a chance comment from a colleague about the Have I Been Pwned website. Out of morbid curiosity, I decided to check my personal email address on the site, and was quickly confronted with the knowledge that it appeared in no fewer than 16 separate breach lists. To be fair, I have had the email address in question for a long, long time, and have used it across a variety of sites, but even so, that does make me pause for thought, because it's an address I still regularly use.

The obvious question is: What do I do next? Finding out that my email address was possibly compromised is one thing, but what does that actually mean? What should I do to protect myself from further attacks? Do I need to change my passwords? Do I assume that every account, website, and application tied to that email address is compromised? For the answers, you'll need to turn to page 24. The important thing to do, though, is make sure you don't panic.

Another topic to try to stay calm about is the soon-to-be-retired Windows 7. There are plenty of machines out there still running the aging operating system (a recent report had it at 43 percent of all machines, in fact), but when support for normal users ends at the end of the year, where does that leave these systems? Turn to page 44 to find out what your options are, including how to keep your machines going once Microsoft pulls the plug—as well as what that actually means.

A much calmer subject to plan for is the inevitable move to 8K displays. This is a bit further away than Microsoft turning off one of its operating systems, and there are plenty of problems that the industry as a whole needs to overcome first, but it's pretty much a given that screen resolutions are going to keep increasing. So, what do you need to do to get ready for the next big shift, and what does it mean for any hardware upgrades? Turn to page 38 to find out more.

Our other main feature this issue (starting on page 30) looks at what is (and isn't) important when it comes to selecting your next processor. Whether you're looking to upgrade one of your machines or build a system from scratch, or you're just interested in what goes into piecing together a new CPU, this is a great read.

I hope you enjoy the issue!

Alan Dexter is Maximum PC's *executive editor and a punisher of hardware. He's been a tech journalist for over 20 years, and has no problem upsetting the PC industry as a whole.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Business-Ready VR

Virtual and augmented reality aim for new markets

YOU'D BE FORGIVEN for thinking that VR is dead, but not everyone got the memo. HTC has upgraded its standalone Vive Focus to the Vive Focus Plus. You now get a controller for each hand, plus they have six degrees of freedom, and track as you move them. It's powered by a Qualcomm Snapdragon 835, and has a 3K AMOLED display, matching the more expensive Oculus Quest. The headset is still rather large, and not exactly stylish, but is lighter than it looks.

The original Vive Focus cost "from" $599; the Plus won't be far off this. It is really aimed at the business market, for medical training, and suchlike, but there's a chance you'll see them in game arcades. HTC is working with developers, and has its Vive Wave project, a unified platform for applications that includes SDKs to port PC applications.

Microsoft has also updated its standalone headset. The HoloLens 2 is a mixed reality or augmented reality headset, which superimposes virtual elements on to the real world. It has switched to a Snapdragon 850 processor, and has an expanded field of view, a weakness of the original. The resolution has jumped from 720 per eye to 2K, making the holograms far crisper. The headset is lighter, thanks to carbon fiber, and you can now flip the visor up.

Microsoft has been quietly working to establish a business market for the HoloLens. It isn't cheap: $3,500 for the headset, or you can pay from $125 a month to include Dynamics 365 Remote Assist, where "employees can work smarter" and "solve problems in real time." Behind the babble, it is clever stuff; you can overlay things remotely, so one engineer can point exactly to the button another engineer should press next. Microsoft has also signed a $479m contract with the US military to develop HoloLens apps, causing some internal tensions—100 employees publicly wrote to Microsoft's president on the day of the HoloLens 2 launch to object.

What are these devices for? Well, promotional material speaks in nebulous terms of business applications, training, and solving undefined "problems." Some uses are obvious: An architect walking through his building plans, or a surgeon practicing on compliant bodies, make total sense. You can teach someone to operate or fix something large and expensive, without having to have something large and expensive there. However, every desk doesn't need one, which is a problem if you want to sell lots of headsets.

Virtual and augmented reality still appear to be products looking for a market. Gaming is an obvious sell, but even that hasn't broken into the mainstream, despite modern headsets delivering a pretty awesome experience. Beneath all the fluff, the Focus Plus and HoloLens 2 are at heart just smartphones you wear on your head.

Sales of VR are good or bad, depending on what you read. Last summer, sales were said to be in a tailspin. Recently, they've been reported as buoyant, with 1.9 million sales in the third quarter of 2018. According to the International Data Corporation, the AR and VR market grew by 9.4 percent. Standalone headsets, thanks to the launch of the Oculus Go and Xiaomi's Mi VR, grew by 428 percent. Percentages can look impressive, but what matters is real numbers. Sony has shipped three million PlayStation headsets, which sounds a lot, but spread across the world it isn't, or in comparison with PlayStation sales—Sony has sold over 90 million of those.

Remember the computer in *Minority Report?* Microsoft has an AR headset and an OS. You could pare down the headset to just the eye and gesture tracking, with a Wi-Fi connection to a base unit, making what you wear small and light. Then you could have Windows laid out across the room. We'd love to see that. But it would face the same problem as all these systems: Impressive as they are, do you want to spend cash on it? **–CL**

This is how Microsoft sees its HoloLens being used.

> “Virtual and augmented reality still seem to be products looking for a market.

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TURING CORE GOES GTX

Nvidia's new GPU reaches the mainstream

NVIDIA'S JUICY NEW GPU architecture, Turing, has made its first appearance beyond the flagship RTX range, in the form of the GeForce GTX 1660 Ti. Yours for a considerably more wallet-friendly $279. What you don't get are the ray tracing or Tensor AI cores. What you do get is Nvidia's latest and fastest architecture; it claims the 1660 Ti is 50 percent faster than a GTX 1060. A little optimistic perhaps—first reports clock it at around a third faster, around the GTX 1070 level. It's also around 25 percent faster than a Radeon RX 590, and steps on the toes of the RX Vega 56 in some benchmarks. We'll have all the hard numbers for you next issue.

The GeForce GTX 1660 Ti is based on a new version of the Turing core, the TU116, a much smaller piece of silicon than the sizable RTX chips. It has 1,536 CUDA cores (the RTX starts at 1,920), and runs at a base clock of 1,500GHz, with a boost of 1,770GHz. Feeding this is 6GB of GDDR6 on a 192-bit bus, the same as an RTX 2060, but with slightly slower memory. AMD's response? It dropped the price of a few RX Vega 56s to $279, a 30 percent drop. Similar price drops for the RX 590 and 580 are expected, to $229 and $199 respectively.

The RTX's features are dazzling, but for most uses, it's busy working on traditional rasterization, and this is still the measure of things. This is the card many have been waiting for, including Nvidia, as its income is slipping. Sales of the RTX series haven't been too good; high prices and lack of game support haven't helped. The market is also still rearranging itself after the cryptocurrency mining boom slowed sharply, and left a lot of inventory sitting in warehouses, including many GTX 1060s.

A GTX 1660 is due in spring for around $225, and a GTX 1650 for $179, piling on the pressure for AMD to lower Radeon prices, before it unveils its new Navi cards in summer. Then we can relish the two new architectures going head to head. **–CL**

ARE PASSWORD MANAGERS SAFE?

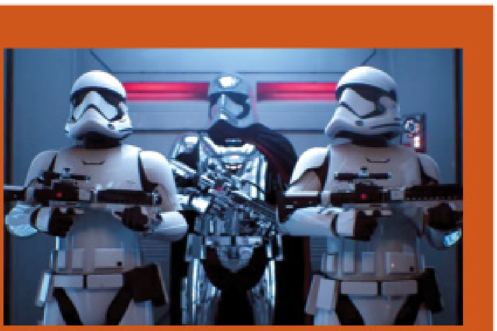
NOT AS SECURE AS YOU MIGHT EXPECT

PASSWORDS ARE A NOTORIOUS security weak spot, and we now have an estimated average of over a hundred each, according to a research paper on the subject. The Independent Security Evaluators, a consultancy company, has released a report claiming that the five most popular Win 10 password managers contain security flaws. Tests revealed that when running, passwords weren't being effectively deleted from memory after use.

Don't panic: Your passwords are heavily encrypted when the password manager isn't running. The only way to access passwords stored by a manager is to sneak around in system memory, which requires an in-depth malware attack known as memory scraping. ISE says it wants to "establish a reasonable minimum baseline which all password managers should comply with." The report has ruffled a few feathers, so let's hope the app developers respond by scrubbing passwords from the memory. **–CL**

TOP GAME ENGINES GET RTX SUPPORT

Unreal and Unity back ray tracing



EPIC WAS RESPONSIBLE for the stunning *Star Wars* demo that helped bring home what ray tracing could do, and the company has now integrated low-level ray-tracing support via DX12 into its Unreal Engine 4.22, the biggest name in PC game engines, with an impressive list of features, including reflections, translucency, ambient occlusion, and soft shadows. Second only to the Unreal engine is the cross-platform Unity engine, from Unity Technologies. It, too, is to add ray-tracing support, or so a email from Nvidia's CEO Jensen Huang let slip (there is, as yet, no official announcement).

We'll have to wait for this to filter through to games with ray tracing built in from the ground up, but the important first step has been secured. There's still only a couple of games that make a go of using ray-tracing features to any effect. As ever, hardware moves at a much faster pace than software—it is going to be a frustrating time for RTX owners for a while yet. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **NEW CPU TECH**
Intel reckons that the Magneto-Electric Spin Orbit process is 10 years away or less—faster and better for AI than silicon.

✓ **THE 100K CART**
An early, super-rare version of *Super Mario Bros.* has sold for $100,150.

✓ **RASPBERRY WINDOWS**
Somebody has managed to get Windows 10 running on the diminutive $35 Raspberry Pi Model B. Why? Why not?

TRAGEDIES

✗ **APP BRICKS SNEAKERS**
The app for Nike's self-lacing shoes has failed, leaving people unable to wear them.

✗ **BYE-BYE BLU-RAY**
It looks as if the days of the disc really are numbered; Samsung has canceled all development of new Blu-ray players.

✗ **FACEBOOK HEALTH RISK**
Eleven apps, including health trackers, have been found to share sensitive data with Facebook without consultation.

Welcome Windows Lite

WINDOWS IS NOT the world's most popular operating system, by some margin. That would be Android. And the gap is growing. Over half of everything sold running an OS is running Android. Microsoft lost the fight for the smartphone years ago, but higher up the technology tree, it still thinks there's a chance, so there's a new version of Windows on the way, aimed at Chrome OS territory: Windows Lite, as it is currently being called in most quarters. The final name is a mystery, but it may well not be branded as a part of the Windows family at all, to put some space between it and Windows proper. It will still be built around the Windows core, but will diverge from there, including a different user interface, with a new look and feel. It will run Universal Windows Applications and Progressive Web Apps, following the pattern of Chrome. There is also talk of dual-screen mobile devices, and laptop versions.

Microsoft has not had much success with putting Windows on anything other than fully-featured machines, or away from the x86 platform. Windows RT, for ARM chips, made few sales, and died quickly. As did Windows S, another cut-down version for low-end devices. The problem was that it looked just like Windows, only it wouldn't let you run anything you hadn't downloaded from the Windows Store. Then there was the expensive saga of Windows Mobile in its various forms.

This time, Microsoft looks to be doing things differently. Instead of trying to cut down the bulk of Win 10, but keep the look and feel, it is working from the ground up on something designed to be "light," that won't confound expectations. We'll have to wait until spring's Microsoft Builder Developer Conference to learn much more. **–CL**

Lost Crypto Code Costs $198m

When the founder of QuadrigaCX, the Canadian cryptocurrency exchange, died unexpectedly, it caused something of a problem at the company. He was the only person who knew the code to the company's cold wallet, the offline encrypted store of coins. News of his death wasn't released for a month, for fear of a run on the exchange. When news did emerge, there was indeed a rush to withdraw coins—unsuccessfully. The company has now filed for creditor protection, and is in the process of closing down. Meanwhile, $198 million worth of cryptocurrency has been lost, and 115,000 QuadrigaCX customers are left out in the cold. A salutary lesson: If only one person has access to the key, it can all go horribly wrong. It has been estimated that a quarter of all bitcoins have been irrevocably lost so far. **–CL**

Google Drops Adblocker Block

Last month, Google's Chrome Manifest V3 document told us it planned to change the way the extensions function operated, which would have scuppered attempts at blocking ads. The response was quick—and not friendly. The change was proposed for performance reasons, but developers of Chrome extensions retorted with tests that highlighted the minimal impact adblockers have on speed. Google has called a moratorium on the changes, and is said to be "discussing" with developers what changes should be made. Good. Once you've used adblockers, it's difficult to go back to the crowded, sluggish version of the web, with its unexpected videos. Over a third of desktop systems and over 40 percent of laptops use one, and numbers are rising rapidly. Making it impossible would annoy a lot of people, and push them toward Firefox. **–CL**

THE YEAR OF THE FOLDING PHONE

Half phone, half tablet, wholly expensive

NOT LONG AGO, they'd have been something out of a sci-fi story, but folding phones are now here. Samsung's Galaxy Fold (above) looks much like a traditional phone, albeit about twice as thick. There's the usual screen on one side, but it opens out to reveal another larger screen inside. The small screen is a 4.6-inch 1960x840 OLED panel; the interior screen is the size of a small tablet at 7.3 inches and 2152x1536 pixels. It has six cameras, including the triple camera set we'll see on the Galaxy 10. It has 512GB of storage and 12GB of RAM. The Galaxy Fold will be available at the end of April in LTE and 5G versions, and prices start at $1,980. Yes, these things are not going to be cheap.

Huawei's Mate X (below) has its screen wrapped around the outside, and is usefully thinner. Unfolded, it's 8.0 inches and 2480x2200 pixels. When closed, you have a 6.6-inch screen on one side and a 6.38-inch one on the other. It makes do with just three cameras. It also has 512GB of storage, but slightly less RAM at 8GB. It's sleek, but the exposed folding screen does look vulnerable. It'll be available this summer at around $2,600. However, there are currently no plans to bring it to the US. A pity, as it looks to be the better of the two.

Don't worry, though, because there are plenty more to follow. Oppo, LG, and Xiaomi are all expected to launch folding models this year. Motorola also has a rather cool-looking flip-phone based on the iconic Razr, which has a folding screen inside. The notable absentee in this first round of hardware is Apple. **–CL**

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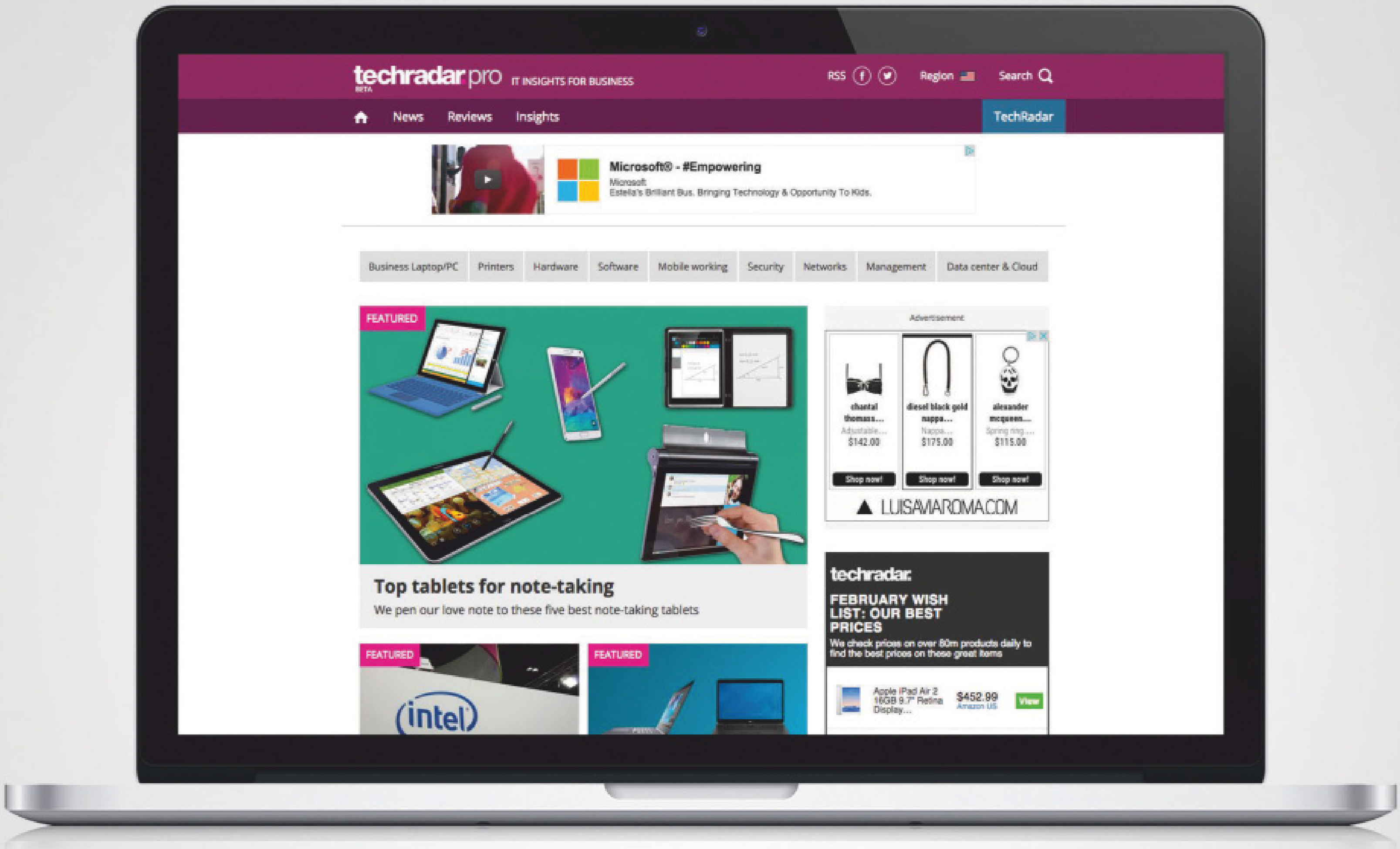

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TECH TALK

A Closer Look at DLSS

I ORIGINALLY HAD high hopes for Nvidia's DLSS technology—that's Deep Learning Super Sampling, an AI enhanced solution to antialiasing, if you buy into the marketing material.

DLSS boosts performance quite a bit in *Metro Exodus.*

Perhaps it will get better with additional training and tuning, and Nvidia certainly talks a good story in that respect: "Our supercomputer never sleeps, and we continue to train and improve our deep learning neural network even after a game's launch. When we have improvements to performance or image quality ready, we provide them to you via Nvidia software updates."

But here's how I see it. With three games now supporting DLSS—*Battlefield V, Final Fantasy XV,* and *Metro Exodus*—it's starting to feel more and more like DLSS is a crutch that's needed to give the RTX cards a chance to handle ray tracing, rather than something that will enhance the image quality. It doesn't help that Nvidia is extremely coy about how it all works, and even the Turing architecture whitepaper omits key details. What resolution is actually used before DLSS applies its upscaling and antialiasing algorithm? I've heard half the pixels (meaning 2715x1527 for 4K), but no hard data exists to confirm this.

Obviously, rendering half as many pixels relieves a big strain on your GPU cores, but do the ends justify the means? That's where I'm far more skeptical. I've compared screenshots in all three supported games, as well as the two supported benchmarks (3DMark Port Royal and the Unreal Engine Infiltrator demo). If your baseline is heavy temporal AA with extra blurriness, DLSS works as advertised. But when looking at most games, there's a clear loss in detail—about what you'd get if you took a 2560x1440 image, upscaled it to 4K, and then applied a blur filter in Photoshop.

It's probably a bit better than that, and the fact that Nvidia's RTX GPUs are able to do all of that in real time at more than 60fps is certainly impressive. And maybe it will eventually reach the point where the trained algorithm will actually come close to matching native rendering quality, without the jaggies. Right now, however, DLSS tends to add too much blur for my taste.

Perhaps not so surprising is that the results in Port Royal and Infiltrator are a lot better than what you get in games. Both demos run a fixed path, with perhaps 10,000 unique frames. Repeatedly train a deep learning network with those frames, and you're almost certain to get better results than in a game where there is literally an infinite number of unique frames to analyze. That's why Nvidia needs to allow its Titan supercomputer (one of the fastest in the world, if not the actual fastest) crank away for days or even weeks to improve the output.

Personally, I'm far more interested in seeing some games implement DLSS2x, which skips the upscaling and merely focuses on antialiasing. It won't boost performance and, in fact, it could actually reduce frame rates, depending on the game. But whereas DLSS is currently limited to 1440p and 4K for the RTX 2080 and above, or 1080p and up for the RTX 2060 and above, DLSS2x shouldn't have to worry about your current resolution. It would be a quality antialiasing alternative, rather than a performance boost. Unfortunately, so far, no public demos that support DLSS2x exist.

The kicker is that the RTX cards need DLSS to achieve acceptable frame rates in the two ray-traced games that currently exist. Without DLSS, the RTX 2060 and 2070 fall short of 60fps at 1080p high/ultra with ray tracing enabled; the RTX 2080 can't quite manage 1440p 60fps with DXR; and the 2080 Ti and Titan RTX are nowhere near 60fps at 4K. Turn on DLSS, however, and all of those cards get a lot closer to that 60fps target.

And keep in mind that *Metro Exodus* is only using ray tracing for global illumination, *Battlefield V* only uses it for reflections, and *Shadow of the Tomb Raider* (eventually, if the promised patch ever arrives) only uses it for shadows. If you're like me, and you want games to include ray-traced shadows, lighting, reflections, refractions, and global illumination, we're going to need two or three times as many RT cores as the current RTX GPUs, and even then, we'll probably still need DLSS to help out.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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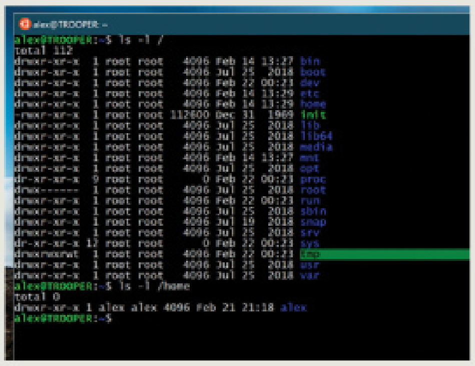
Alex Campbell

OPEN SOURCE

WSL Opens Up Access to Linux Files from Explorer

MICROSOFT HAS LONG WARNED Windows Subsystem for Linux users against attempting to modify files on a Linux distribution from the Windows file manager. However, a new update due out in April will allow Explorer to do the things Redmond has warned against, with a couple caveats.



```
alex@TROOPER:~$ ls -l /
total 112
drwxr-xr-x  1 root root   4096 Feb 14 13:27 bin
drwxr-xr-x  1 root root   4096 Jul 25  2018 boot
drwxr-xr-x  1 root root   4096 Feb 22 00:21 dev
drwxr-xr-x  1 root root   4096 Feb 14 13:29 etc
drwxr-xr-x  1 root root   4096 Feb 14 13:29 home
-rwxr-xr-x  1 root root 112600 Dec 31  1969 init
drwxr-xr-x  1 root root   4096 Jul 25  2018 lib
drwxr-xr-x  1 root root   4096 Jul 25  2018 lib64
drwxr-xr-x  1 root root   4096 Jul 25  2018 media
drwxr-xr-x  1 root root   4096 Feb 14 13:27 mnt
drwxr-xr-x  1 root root   4096 Jul 25  2018 opt
dr-xr-xr-x  9 root root      0 Feb 22 00:21 proc
drwx------  1 root root   4096 Jul 25  2018 root
drwxr-xr-x  1 root root   4096 Feb 22 00:21 run
drwxr-xr-x  1 root root   4096 Jul 25  2018 sbin
drwxr-xr-x  1 root root   4096 Jul 19  2018 snap
drwxr-xr-x  1 root root   4096 Jul 25  2018 srv
dr-xr-xr-x 12 root root      0 Feb 22 00:21 sys
drwxrwxrwt  1 root root   4096 Feb 22 00:21 tmp
drwxr-xr-x  1 root root   4096 Jul 25  2018 usr
drwxr-xr-x  1 root root   4096 Jul 25  2018 var
alex@TROOPER:~$ ls -l /home
total 0
drwxr-xr-x 1 alex alex 4096 Feb 21 21:18 alex
alex@TROOPER:~$
```

The separation between Linux and Windows folders will soon fall.

The Windows Subsystem for Linux—WSL for short—has been a fascinating tool for Windows users. It has some really interesting uses, namely the ability to run Linux console programs such as `ssh` as though you were running a Linux distro on bare metal. In short, it allows Windows users to use Linux tools without spinning up a virtual machine or dual-booting. It's a great way for Linux newbies to practice terminal commands without having to muck around with setting up a Linux box.

All this is well and good, but the inability to access files on a Linux system from Windows has been a limitation. A simple example has to do with file editing. If you prefer using a GUI text editor, such as Visual Studio Code, Notepad++, or Atom in Windows, it can be a little daunting or unpleasant to be forced into tools such as `nano` or `vim`.

Microsoft had a very good reason to keep the Linux systems segregated from Explorer and user meddling: Windows has a different user and permissions structure from POSIX systems, such as Linux or Unix. In most every Linux system, a file or folder has a user, group, and other metadata, such as file mode, associated with it. Windows has those features, too, but they're handled differently, and the two systems aren't compatible.

A WSL distribution also has its own set of users. That is to say, the Windows user `Alex` won't be the same `alex` on an Ubuntu WSL instance. If `Alex` decides to modify a file on the WSL system, the Ubuntu system won't know who altered the file, and the file will likely have malformed metadata. On top of this, the Windows system process that provides access to the filesystem for the WSL will be shown files that don't belong to it.

> This feature has about the same effect as mounting an SSH connection in Windows.

To get around this, the new feature will allow users to run `explorer.exe` while logged in to their WSL distro as a user. This command will launch a Windows Explorer window with the WSL distro's filesystem mounted as a network share. This has about the same effect as mounting an SSH connection in Windows (or Linux). The Explorer window will start in the Linux user's home folder, but will also show the filesystem as that user sees it. All file actions performed in Windows on this share are done as the user who ran the `explorer.exe` command. So, if `alex` runs `explorer.exe`, everything `Alex` does will appear to be done as `alex`.

PowerShell users will also be able to access the filesystem at the path \\wsl$\<distribution name>\.

There are some limitations to this so far. As of writing, this feature can only work when a logged-in user executes the command, as Linux file permissions have to be preserved. (The user `alex` won't be able to modify files that belong to `root`, for instance.) Microsoft says that access to files on non-running distro instances is being worked on for a future update.

This is certainly cool for people who want to manipulate files and code in Windows without having to copy things back and forth in roundabout ways. While Windows still can't natively read Linux filesystems like ext4, this is a big step up from having to duplicate effort across Linux distro installs.

At time of writing, the new feature—in build 18342 for the 19H1 release—is only available to Windows Insiders receiving Fast Ring updates. Furthermore, this release is not available to Windows boxes running on certain Intel CPUs. For those who don't have the need or tenacity to be on the bleeding edge, not to worry: This update will be rolling out in regular Windows updates soon enough.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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THE LIST

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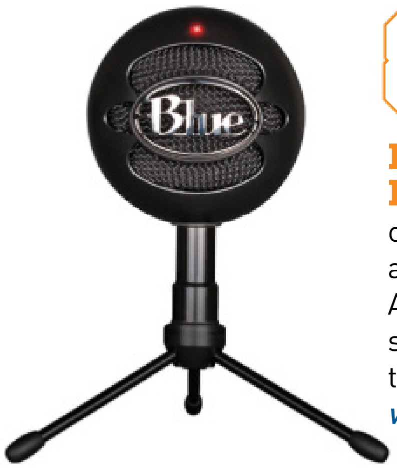


8

BLUE SNOWBALL ICE Compact, simple, cute, and cheap—with awesome sound quality. A well-deserved staple starter for newcomers to desktop mics. *$60* *www.bluedesigns.com*

7

BLUE YETI PRO You can save a little by opting for the standard Yeti, but the XLR ports of the Pro make it useful even if you move on from USB. *$250 www.bluedesigns.com*

6

FIFINE USB MICROPHONE Not a known brand, not pro-level quality, but a highly credible sound recording package, considering its minimal price. *$22 www.amazon.com*

5

RØDE PODCASTER There's no reason to use a condenser mic in most situations; this dynamic alternative is perfect for untreated acoustic environments. *$250 www.rode.com*

4

APOGEE HYPEMIC A high-end integrated analog/digital converter means the HypeMic can send zero-latency 24-bit/96kHz signals to your PC. *$350* *www.apogeedigital.com*

3

AUDIO TECHNICA ATR2100 A high-quality XLR-capable handheld stage mic—one that also sports USB for equally awesome desktop use. *$79* *www.audio-technica.com*

2

SAMSON METEOR The integrated stand makes it look like a *Portal* turret, but the Meteor isn't deadly. It is both portable and powerful, though. *$56* *www.samsontech.com*

1

CAD AUDIO U37 Entry-level price, from a little-known pro brand, but CAD's mic—available in a host of lurid colors—sounds great. *From $69* *http://cadaudio.com*

HEAD TO HEAD

BY **JEREMY LAIRD**

AMD FreeSync 2 vs. Nvidia G-Sync

The contest between G-Sync and FreeSync adaptive refresh tech is Nvidia versus AMD in a nutshell. G-Sync is proprietary and expensive, while FreeSync relies on open standards. Nvidia says that having full control over G-Sync enables a better experience, while fans of FreeSync note that the latest standard adds a range of additional capabilities. What's more, Nvidia has now unlocked FreeSync compatibility for its GPUs, putting a new spin on things.

ROUND 1

Innovation

This has to go Nvidia. It was first to market with G-Sync in 2013. G-Sync gets a hard rap for its proprietary nature, the need for expensive modules in the display, and the fact that G-Sync only works with Nvidia GPUs. But in 2013, something along those lines was the only way to make adaptive refresh possible in a desktop scenario. AMD responded within six months with FreeSync. Problem was, in that early form, FreeSync was only possible courtesy of the variable refresh profile in embedded DisplayPort (eDP), a feature designed for power saving rather than making games more slick. By May 2014, AMD and the standards body VESA had worked together to add adaptive refresh as an optional extra for the 1.2a iteration of DisplayPort, and it was game on. You could argue that FreeSync 2 has since upped AMD's innovation ante. You might even take the view that G-Sync has meanwhile stagnated, which is why Nvidia eventually caved, and added FreeSync support to its 3D boards. But it's also possible none of this would be happening had Nvidia not blazed a trail with G-Sync. So, we're happy to give Team Green the nod on this one.

Winner:
G-Sync

ROUND 2

Compatibility

The obvious winner is FreeSync—it's based on open standards, and makes fewer demands of monitor makers. It's essentially a part of the DisplayPort standard, rather than tied to a graphics vendor. What's more, with Nvidia now supporting the VESA adaptive refresh interface with its graphics cards, FreeSync now works with both AMD and Nvidia GPUs. G-Sync, meanwhile, is locked to Nvidia boards, and demands that monitor makers integrate an expensive scaler module. The slight complicating factor is that FreeSync 2 sets out a broader array of requirements for compliance. Simply including the latest DisplayPort interface no longer cuts it. Features like HDR support and low frame-rate compensation certainly up the appeal and capability of FreeSync displays, but they also make it harder for monitor makers to create compatible displays. It's also worth noting that only Nvidia graphics cards deliver support for both G-Sync and FreeSync. So, it's not an absolute and unambiguous win for AMD, but FreeSync is the more open platform. When Intel enters the market and supports FreeSync, the end will probably be nigh for G-Sync.

Winner:
FreeSync 2

ROUND 3

Value

The value proposition of G-Sync is problematical. That's because it's a proprietary hardware solution, while FreeSync is standards based. G-Sync requires a special scaler module that contains an Altera Arria V GX family FPGA featuring 156K logic elements, 396 DSP blocks, and 67 LVDS channels. Produced by TSMC on its older 28LP process, and paired with three DDR3L DRAM chips, the result is a fair few middle men, and quite a bit of margin taking that the end user must fund. Thus, G-Sync monitors tend to cost at least a hundred dollars more than otherwise comparable models. In the early days, the justification for that was quality of experience. With G-Sync, you had a monitor that had been honed and optimized, particularly when it came to combining adaptive refresh with pixel overdrive. Early FreeSync panels were patchy, with some suffering from ghosting. FreeSync implementations are now more consistent, making the value proposition of G-Sync more questionable. However, for FreeSync 2, the more extensive requirements for qualification put upward pressure on pricing, even if you do get more features for your money than G-Sync.

Winner:
FreeSync 2

HEAD

SAMSUNG
QLED GAMING MONITOR

ROUND 4

Gameplay

This, surely, is what it's all about: delivering buttery smooth, tear-free gaming. G-Sync is expensive and locked to Nvidia hardware, but the payoff is the slickest, most polished gaming experience possible, right? It's certainly true that G-Sync was the more reliable solution in the very early days. Nvidia put significant work into making G-Sync as polished as possible. That included not only optimizing it to function properly with pixel overdrive, but also features such as so-called collision avoidance, designed to help in low-frame-rate conditions, where the panel is being updated with duplicate frames as a stop-gap while waiting for a new frame to be rendered. It uses algorithms to avoid a scenario where a new frame is ready but has to wait for the panel to finish being updated with a duplicate frame. FreeSync has its own solution: Low Framerate Compensation support. This broadens the range of refresh rates over which FreeSync operates, and ensures better performance at lower frame rates. It used to be an optional feature; with FreeSync 2, it's compulsory. So, there's now nothing in it from a subjective gameplay experience perspective.

Winner:
Dead heat

ROUND 5

Additional Features

Are there other features that aren't directly related to achieving and optimizing adaptive refresh rates that might tip the balance? That's not a straightforward question to address, partly thanks to an arguable lack of clarity around G-Sync's specifications and requirements. You'll see references to G-Sync HDR monitors, for instance, but that, ultimately, refers to a G-Sync monitor with added HDR capability. HDR is supported by G-Sync, rather than being required by it. For FreeSync 2, however, HDR is very much a marquee feature. In fact, FreeSync 2 takes a novel approach to HDR rendering. The conventional approach involves tone mapping the requisite dynamic range twice, first in the game to comply with an HDR standard like HDR10, and then again in the monitor to map from HDR10 to the monitor's native dynamic range. FreeSync 2 simplifies that by enabling games to tone map directly to a monitor's native dynamic range. In theory, this can save a few precious milliseconds and improve response in HDR games. In practice, it requires specific support from game developers, which is less than ideal.

Winner:
FreeSync 2, in theory

And the Winner Is...

In the very early days of adaptive refresh tech, it was difficult not to give the nod to Nvidia's G-Sync. There were decent implementations of FreeSync monitors from day one, but if you had to pick G-Sync and FreeSync monitors at random, you could rely on the G-Sync option delivering a good experience. FreeSync? Not so much. That's no longer the case. Even before FreeSync 2 arrived, most FreeSync monitors were delivering the goods in terms of a smooth, slick gaming experience without any obvious image quality problems. With FreeSync 2's required LFC feature, plus some low latency goodies, the gap has closed to nothing from a gameplay perspective. That, no doubt, is at least part of the reason why Nvidia has unlocked FreeSync support for its GPUs. The move is a tacit admission that the end is nigh for G-Sync. As a proprietary technology, it must be unambiguously better than the open-standard alternative. If that ever was the case, it isn't any longer. Which is why FreeSync 2 not only wins our contest, but it will almost certainly end up dominating in the real world. ⏻

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Self-Spamming
> Linux on the Go
> SSD Migration

Accessing Boot Menu

Hello Doc, In a fairly recent issue—which I can't find—you described how to access the Windows 10 boot menu. I believe this is in Safe Mode, but would it be possible to go over the directions again? I know it had something to do with holding the Shift or Alt key before or during the reboot process, but I can't remember how it went.

–Carl Smith

THE DOCTOR RESPONDS: If you're starting from the Windows desktop, open the Start menu and press the "Power" button. Hold the Shift key on your keyboard, then click "Restart." After a few seconds, the advanced boot menu appears. This should allow you to reboot from a physically attached device or a network target, reinstall Windows, recover to a System Restore point, uninstall updates you no longer want, access the command prompt, or get into your UEFI. That last option is particularly useful if Windows typically boots before you can mash the Del/F2 key to alter BIOS settings.

Blocking Spam

Greetings from Puerto Rico, Doctor. Lately, I've received a ton of spam email, some of which appears to come from me. Obviously, I can't block myself, so how can I stop spammers from filling my inbox with more garbage? And how are they sending emails using my name?

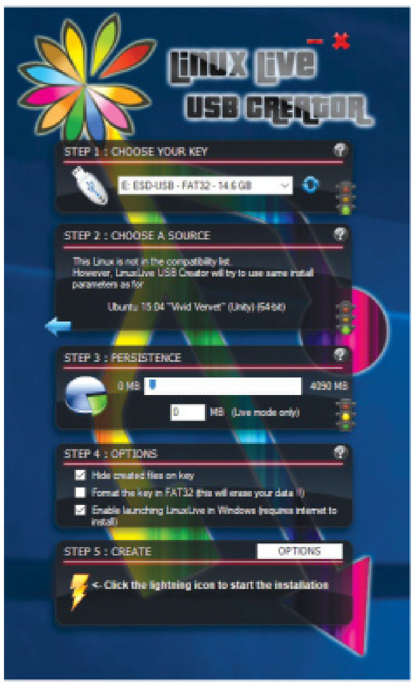
–Jaime Gutierrez

THE DOCTOR RESPONDS: Spam email is a massive time-waster. Nobody wants to sift through their inbox, figuring out which messages are legitimate. The Doc receives hundreds of junk emails a day, so he is especially sympathetic, Jaime.

The Doc uses a couple of strategies for combatting the onslaught. First, he uses multiple email addresses, some of which are more or less disposable. Personal communications are sent to and replied from one address, which is never input into online forms. Online shopping happens through another email address. Work messages go through a third alias. By making smart choices about what email goes where, the Doc can pull the plug on certain accounts, and start new ones as needed.

Sometimes junk does make it through to one of the addresses used on a regular basis. For those, the Doc uses Outlook's built-in spam-handling capabilities (most locally installed and online email clients have their own versions of this functionality). From Outlook's "Home" tab, click the small "Junk" drop-down and select "Junk Email Options." By default, the software is set to "No Automatic Filtering. Mail from blocked senders is still moved to the Junk Email folder." Change that to "High: Most junk email is caught, but some regular mail may be caught as well. Check your Junk Email folder often." Obviously, you'll have to spend some time monitoring what gets filtered. If a legitimate message is erroneously intercepted, right-click it, expand the "Junk" menu, and select "Not Junk" to move it back to your inbox. Or, choose "Never Block Sender" to prevent future emails from landing in the Junk folder.

When spammers send junk email with your address in the "From" field, they're using a technique called spoofing to circumvent your best protections. Because there isn't much validation required to ensure the sender of an email is who he or she says they are, spoofing is easy to implement. It doesn't necessarily mean that your account was compromised. Many spam/virus filters should detect these kinds of forged messages, though. Take some time to familiarize yourself with the options in your email client, and it should be possible to knock down a lot of what you're seeing clutter up your inbox.



STEP 1 : CHOOSE YOUR KEY

E: ESD-USB - FAT32 - 14.6 GB

STEP 2 : CHOOSE A SOURCE

This Linux is not in the compatibility list.
However, LinuxLive USB Creator will try to use same install parameters as for

Ubuntu 15.04 "Vivid Vervet" (Unity) (64-bit)

STEP 3 : PERSISTENCE

0 MB 4090 MB

0 MB (Live mode only)

STEP 4 : OPTIONS

☑ Hide created files on key
☐ Format the key in FAT32 (this will erase your data !!)
☑ Enable launching LinuxLive in Windows (requires internet to install)

STEP 5 : CREATE OPTIONS

<- Click the lightning icon to start the installation

A thumb drive can run Linux with persistent storage.

Lots of Linux

I'm trying to install Linux to a USB drive so that I can test different distributions without mucking up my

↘ submit your questions to: doctor@maximumpc.com system. About 10 years ago, I used to play around with Linux, and I had multiple distros on a USB drive that I could swap between and try out. They'd retain their state when I installed programs, changed settings, and so on. I lost that drive, though. Now, when I try to achieve the same thing, the installations act as though they're on an optical disc, so I lose the persistent state. Every reboot returns them to a clean installation. Any help would be appreciated, and any distro is acceptable. **–Chad**

THE DOCTOR RESPONDS: After a long hiatus, the Doc recently got reacquainted with Ubuntu for the purpose of training and inference neural networks. So, he'll walk you through the process using the Ubuntu 18.04.2 LTS build he uses.

Start with a thumb drive with enough capacity to support however many distros you plan to experiment with. Ubuntu's tutorial on creating a bootable USB stick says you need 4GB or more. However, you'd also want room for persistent storage. Next, download the Ubuntu ISO file from www.ubuntu.com/download, along with Linux Live USB Creator, referred to as LiLi, from www.linuxliveusb.com. With your thumb drive inserted, launch LiLi. Choose the USB key as a destination, navigate to the ISO to specify a source, and specify the amount of storage to set aside for persistence. Click the lightning icon under "Step 5," and let the utility do its job.

Migrating to New SSD

Hey Doc, Now that prices have started to come down for M.2-based drives, I want to upgrade my Samsung 960 PRO NVMe M.2 512GB to a Samsung 970 EVO NVMe PCIe 2TB. However, I don't want to lose all my settings and software, especially since I just upgraded the system and performed a fresh install. So, what do I need in order to clone the existing SSD and add the operating system image to the new one? **–Daryl Austin**

THE DOCTOR RESPONDS: Macrium Reflect 7 Free Edition (www.macrium.com/reflectfree) gives you the ability to create live images of a running Windows operating system or directly clone your SSD to another drive.

If you have an old hard drive with enough room for your SSD's contents, use Reflect 7 to write an image of the 960 PRO with the "Image this disk…" option. Choose the drive's partitions as your source, navigate to the disk you want to use as a destination, and click "Next." Proceed without a template, feel free to leave the scheduling options at their default values, and do the same for Reflect's retention rules. As you're only migrating once, there's no need to get crazy with customization. Hit "Finish" on the summary screen to start the process.

Alternatively, if you have a second M.2 slot in your PC, you can install the 970 EVO, and use "Clone this disk…" to write directly to the new SSD.

Downloading Office

Hi Doc, I own a legitimate license for Microsoft Office 2013 Professional Plus. I need to reinstall it after replacing a defective hard drive. However, I can't locate the original ISO file, and searching online continually takes me back to Microsoft's website, where they want me to install/upgrade to things I don't want. I just need the simple install program where I can select/deselect various options (I do not need Access, Publisher, PowerPoint, etc.).

Any direction where the original ISO can be found would be appreciated. **–Joe Keller**

THE DOCTOR RESPONDS: Microsoft removed the direct downloads to the ISO. There are plenty of corresponding torrents, but you experiment with those at your own risk.

Otherwise, you can visit www.office.com/setup and enter your product key after signing in to your Office account (though that method installs the entire suite). Or, visit http://setup.office.com/downloadoffice and follow the prompts to sign in, enter your product key, and download Office. Unfortunately, the Doc doesn't have a key for Office 2013 to verify whether this method gives you the option to deselect components. If all else fails, Microsoft's site says you can call (800) 360-7561 from Monday to Friday, 5 a.m. until 7 p.m. Pacific Time to order a replacement disc.

Corsair's TX750W should provide many years of reliable service, but blow it out to clear away dust occasionally.

TX750W
POWER SUPPLY
CORSAIR

PSU on Its Way Out?

Hey Doc, A little over eight years ago, I subscribed to the magazine, and built my first computer. It included an Intel Core i7-2600K, 16GB of DDR3 memory, an Asus GeForce GTX 760, and a Corsair TX750W PSU. The PC is still perfectly good for my family's needs, but the PSU has started making a rattling noise. Given its age, I take the sound as an early warning from a polite component that it's about to "retire." Is there anything I can do to get more life out of this system? Can I use the power supply until it quits, or do I need to replace it now to protect my rig? **–James Breen**

THE DOCTOR RESPONDS: The Doc would start by trying to identify the source of the noise. Most PSUs have few moving parts, so a wire or cable lead is probably making contact with the cooling fan. If that's the case, it shouldn't be difficult to nudge it out of the way through the fan grille.

When was the last time you popped the side panel on your PC and gave it a thorough cleaning, though? Anywhere air is pulled in or exhausted out could be clogged with dust. As you check the power supply for dangling leads, take a can of compressed air to the vents on your case, the heatsink and fan on your CPU, and the cooler over your GPU. Also, consider reapplying thermal paste to the heat spreader on your Core i7. That's a classic processor, but it may not be getting the cooling it used to get from your heatsink.

Up and Running Again

Dear Doctor, Thank you for responding to my query about a lag problem I was having with *Lord of the Rings Online*. I've been playing for a week now and it looks stable, without the episodic lag I had previously. I implemented the suggestions you made, and set the game to emulate Windows 7 using DirectX 10.

I don't know which solution solved my problem, but I'm grateful that I can now enjoy playing without the constant worry of lag slowing me down. *Maximum PC* is a great magazine and I shall continue subscribing for long into the foreseeable future. **–Rob Duncan**

THE DOCTOR RESPONDS: The Doc is glad to hear that your lag issues are resolved, Rob. Game on! ⏻

DON'T PANIC

Find out if your acc have been hacked, and what to do about it, with NICK PEERS

IF THERE'S ONE THING guaranteed to bring you out in a cold sweat, it's the thought of being hacked. Over the years we've armed you with all the tools you need to protect your PC against viruses, hackers, and other forms of malware, but it's an ever-evolving battle. These days, most threats are behavioral—they rely on scammers catching you out with fake emails harboring malicious attachments and links to fake websites.

Even if you're wise to all this, there's one massive weak link: online accounts. Many of us have signed up for dozens of accounts, and secured them with short, memorable, and often reused passwords that are easy to hack. Worse still, even if you've not personally given up your password, chances are at least one online service you use has been hacked, exposing your data to the so-called dark web.

Don't believe us? In January, the Have I Been Pwned website released Collection 1, a compilation of over 770 million compromised online accounts, including login details and passwords. The site offers a search tool that lets you see if you're on the list. And unless you're very lucky or barely use online services, you're almost certainly going to appear.

Don't panic. In this feature, we reveal everything you need to know to find out if you're on the list, what to do if you are, and how to lock down your accounts with free tools and online savvy. Let's get a move on.

PHANT

IF YOU HAVE already been hacked, skip to the "Emergency Actions" section. If you've come to this feature having read up on the recent releases of breached data, let's look at a couple of ways to tighten up your online security.

First, now is the time to use a virtual private network (VPN). Free and paid-for services are available—see the box below. Connecting through a VPN masks your true location as determined by your public IP address—simply connect through the closest location to your own. Why do all this? Because if the Have I Been Pwned website is ever compromised, you don't want to be leaving tell-tale traces of your presence.

VPNs encrypt the content you send and receive to the Internet, but don't hide the data you send to the websites you visit, and you still leave a record of where you've been on your PC. Ensure nothing is recorded by opening a private or "Incognito" window in your browser—disable browser extensions, too, as some record information from private browser windows.

CHECK FOR BREACHES

With a private browsing window open, visit https://haveibeenpwned.com and enter your primary email address, before clicking the "pwned?" button. After a pause, you're shown the results.

These are split into two: breached sites and "pastes." Breached sites include individual sites (such as LinkedIn from 2016 and Dropbox from 2012) and compilations, such as Collection #1. "Pastes" are where hacked usernames, email addresses, and other information have been placed into the public domain on other websites. Scroll down to read about each breach—it provides a title, summary, and the information that was exposed.

Many of these breaches should have already been brought to your attention; any company that's been hacked should email its users, and some went further by forcing all users to reset their passwords. In these cases, the findings are historic, and confirm much of what you already knew.

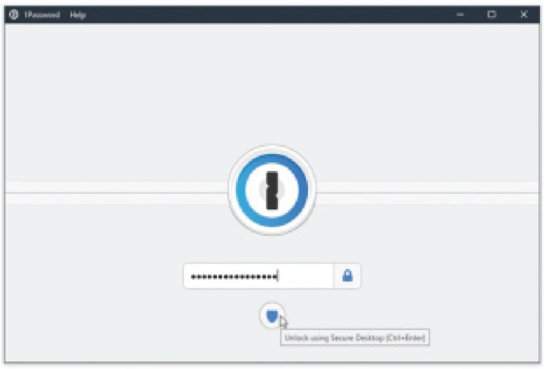
Many of us have more than one email account these days, so perform searches for all the accounts you possess (including web-based services such as Gmail and Outlook.com). Also include any old addresses no longer in use, particularly if you're still using them to log in to certain services.

Have I Been Pwned has an even more important tool. Open a new private tab, and go to https://haveibeenpwned.com/Passwords, where you should enter all those passwords you frequently use, and be appalled to discover most of them have been compromised. Even if you haven't been personally targeted, chances are someone else used the same password, and was hacked.

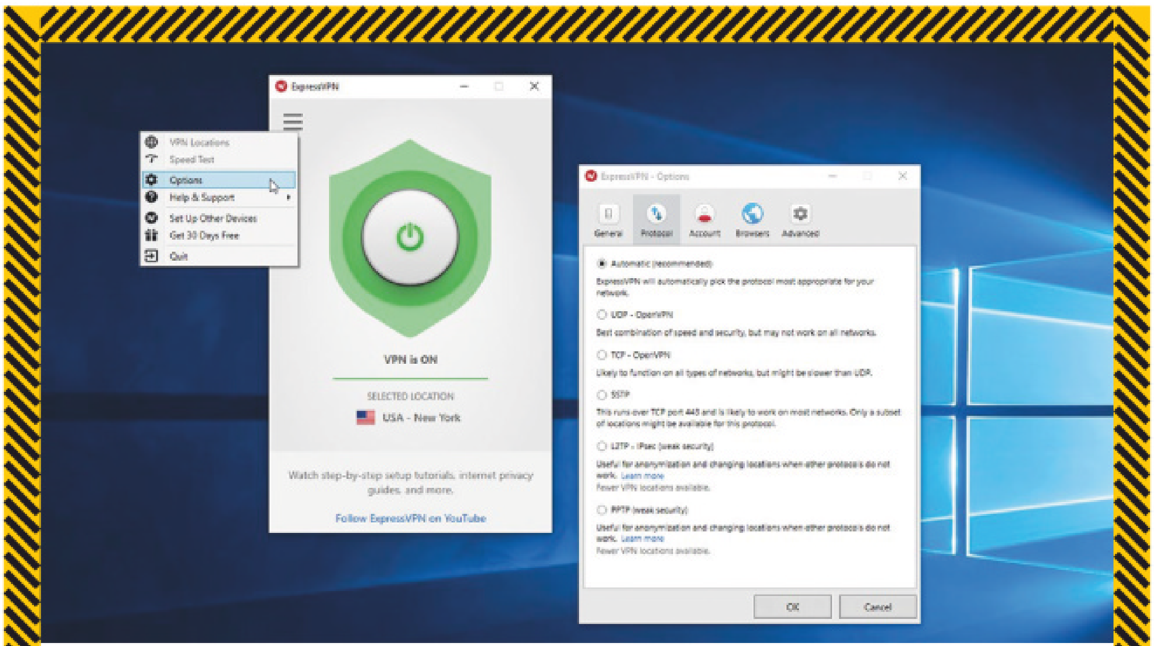
Make a note of them all. You should now have a list of accounts and passwords that have been compromised at some point. These need addressing as a matter of urgency, if you haven't already done so.

A NEW APPROACH TO PASSWORDS

Here's the big takeaway from Have I Been Pwned: You can no longer rely on a handful of short, easily guessable,



Use 1Password's "Secure Login" feature to see off any keyloggers.



● Automatic (recommended)
ExpressVPN will automatically pick the protocol most appropriate for your network.

○ UDP - OpenVPN
Best combination of speed and security, but may not work on all networks.

○ TCP - OpenVPN
Likely to function on all types of networks, but might be slower than UDP.

○ SSTP
This runs over TCP port 443 and is likely to work on most networks. Only a subset of locations might be available for this protocol.

○ L2TP - IPsec (weak security)
Useful for anonymization and changing locations when other protocols do not work. Learn more
Fewer VPN locations available.

○ PPTP (weak security)
Useful for anonymization and changing locations when other protocols do not work. Learn more
Fewer VPN locations available.

SET UP A VPN

We're big fans of virtual private networks on Maximum PC*, and for good reason. They mask your identity and encrypt all data sent and received over the Internet, making them an essential tool if you regularly browse on unencrypted wireless networks, such as public hotspots. VPN providers are ten-a-penny, and there are three we recommend. All work on mobile as well as desktop, letting you cover all your devices, and they all use the tightest forms of encryption.*

*The crème de la crème is ExpressVPN (**www.expressvpn.com**), which checks all the boxes for security, ensuring no personally identifiable traces of your browsing activity are recorded. It has over 2,000 servers spread across over 140 cities in over 90 countries, making it useful for accessing geo-restricted content, too (such as the BBC iPlayer).*

The process of encrypting and decrypting your Internet traffic, plus the extra mileage it travels to pass through your VPN's servers, normally has a measurable impact on performance, but ExpressVPN is so quick, there's no noticeable effect.

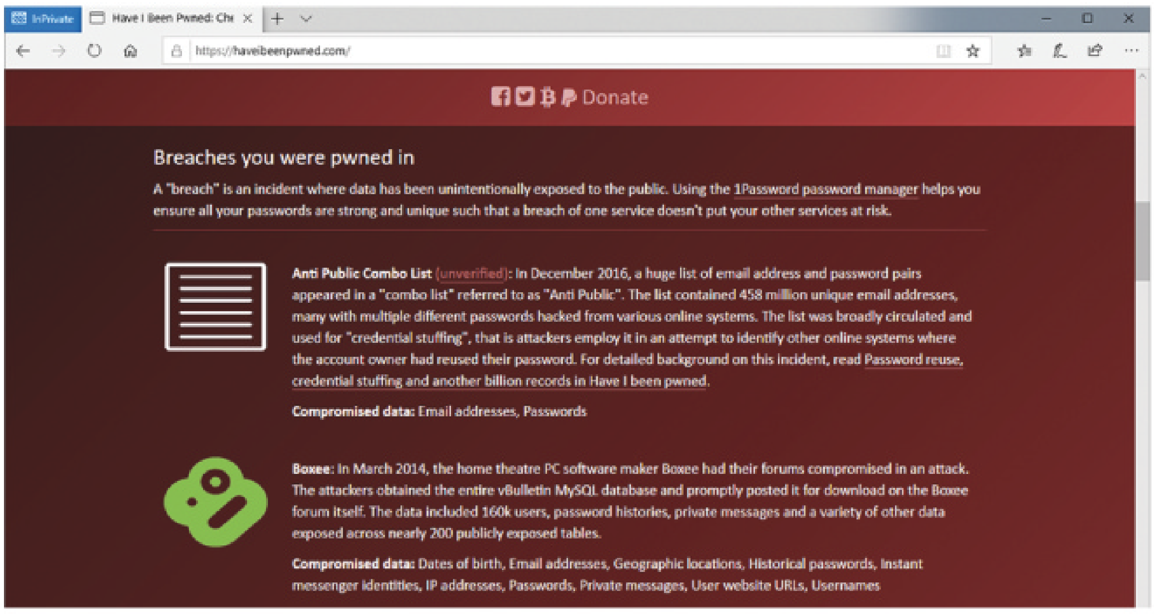
*The issue with ExpressVPN is cost: $12.95 a month, or $99.99 for a year (although at time of writing, you can get 15 months for the price of 12). If that's off-putting, a good substitute is NordVPN (**www.nordvpn.com**), which offers three years for just $107.55 (that's $2.99 a month). It's slower than ExpressVPN, and covers fewer territories, but has over 5,000 servers and can be used on six devices at once (it's just three with ExpressVPN).*

*If you'd rather not pay at all, many services offer cut-down free versions, with a monthly bandwidth cap and limited selection of servers. The most generous is WindScribe (**www.windscribe.com**), which offers 10GB of free bandwidth a month, and allows you to connect through a wide range of countries, including the US, UK, and Switzerland for the privacy-conscious.*

and frequently reused passwords to secure your online accounts. But how do you square the circle of using long, complex passwords, without locking yourself out of your accounts because you mislay or can't remember them?

The answer lies with a password manager—an online tool that generates and remembers all your login details for you, locked in an encrypted vault behind a single master password, the one password you absolutely must remember going forward. The box on page 28 reveals more about choosing passwords.

Password managers offer a Windows app and browser extensions to make it easy to copy and fill in login details without having to type anything. They should offer apps for all your devices—including phone and tablet—and robust security, so if there is a breach, your data remains encrypted and out of touch. A good password manager should also provide alerts to data breaches, and offer various tools to help you target weak and reused passwords.



Breaches you were pwned in

A "breach" is an incident where data has been unintentionally exposed to the public. Using the 1Password password manager helps you ensure all your passwords are strong and unique such that a breach of one service doesn't put your other services at risk.

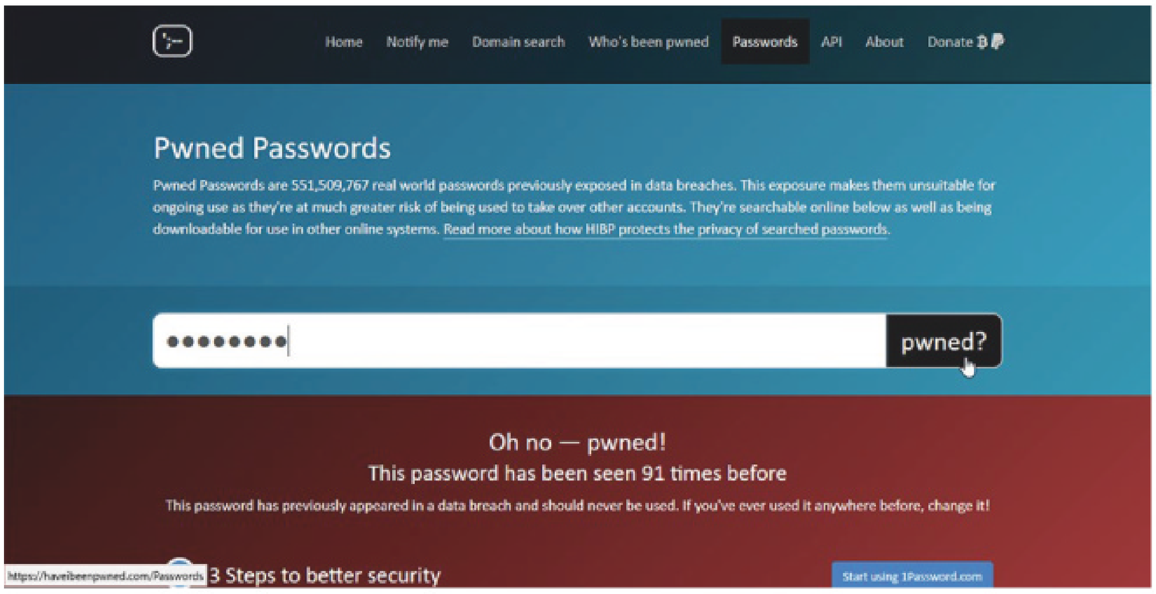
Anti Public Combo List (unverified): In December 2016, a huge list of email address and password pairs appeared in a "combo list" referred to as "Anti Public". The list contained 458 million unique email addresses, many with multiple different passwords hacked from various online systems. The list was broadly circulated and used for "credential stuffing", that is attackers employ it in an attempt to identify other online systems where the account owner had reused their password. For detailed background on this incident, read Password reuse, credential stuffing and another billion records in Have I been pwned.

Compromised data: Email addresses, Passwords

Boxee: In March 2014, the home theatre PC software maker Boxee had their forums compromised in an attack. The attackers obtained the entire vBulletin MySQL database and promptly posted it for download on the Boxee forum itself. The data included 160k users, password histories, private messages and a variety of other data exposed across nearly 200 publicly exposed tables.

Compromised data: Dates of birth, Email addresses, Geographic locations, Historical passwords, Instant messenger identities, IP addresses, Passwords, Private messages, User website URLs, Usernames

Read in depressing detail where your email address has been compromised.



Pwned Passwords

Pwned Passwords are 551,509,767 real world passwords previously exposed in data breaches. This exposure makes them unsuitable for ongoing use as they're at much greater risk of being used to take over other accounts. They're searchable online below as well as being downloadable for use in other online systems. Read more about how HIBP protects the privacy of searched passwords.

••••••••

Oh no — pwned!

This password has been seen 91 times before

This password has previously appeared in a data breach and should never be used. If you've ever used it anywhere before, change it!

3 Steps to better security

Find out which of your passwords have been breached at Have I Been Pwned?

We recommend one of three password managers, according to your needs and budget. Have I Been Pwned endorses 1Password, which costs around $36 a year ($60 for families), and can be downloaded from https://1password.com. It certainly checks all the boxes—we like its Secure Desktop mode, which runs 1Password in an isolated process to keep it out of reach of any keyloggers—but it is expensive.

LastPass (www.lastpass.com) has generously made all of its core functionality free, and we love its security audit, which makes it easy to spot and update weak and breached passwords. But its Firefox extension is rubbish, and the data breach it was involved in still rankles, even though user vaults remained encrypted and out of reach.

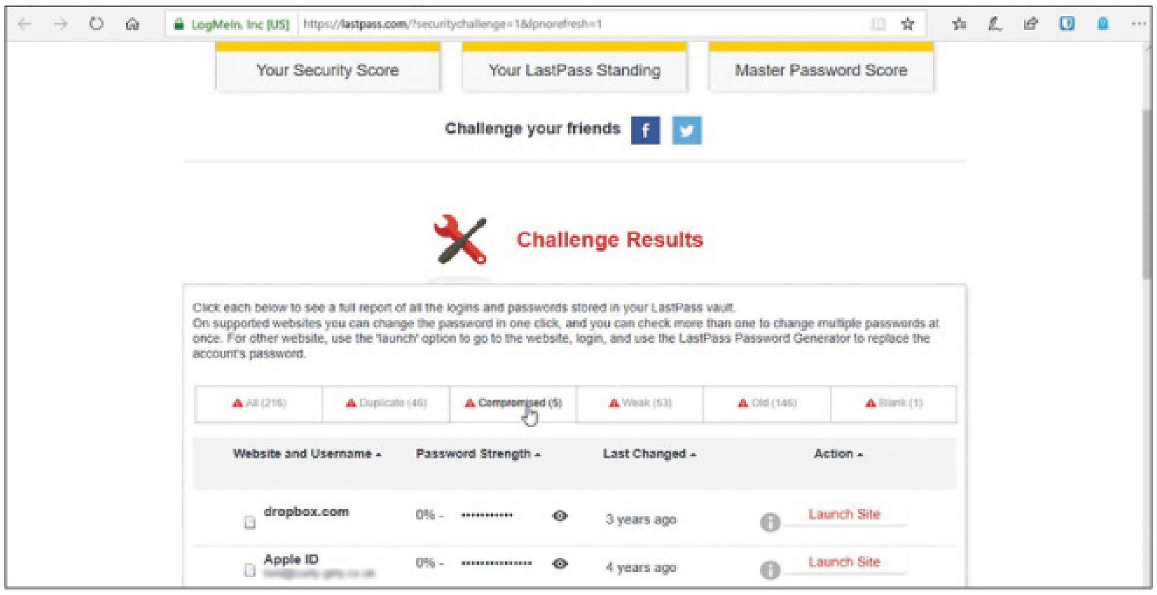
We're personally currently using BitWarden (www.bitwarden.com). It's a little less developed than the other two, but catching up fast. It's open source, most of its functionality is completely free, and its Premium tier is just $10 a year, which unlocks various reports that can identify weak and compromised accounts.

Whichever manager you opt for, they all work in a similar way. Install the browser extension to access your passwords through your browser. A desktop app is also available, but not strictly necessary. Some features in LastPass and BitWarden are also restricted to access through your web vault in a browser window.

Create a new account following our advice to set a strong master password. This is also a good moment to consider adding two-factor authentication (2FA) to your password manager —see the box on page 29 for why and how.

UPDATE WEAK PASSWORDS

If you've set up a password manager for the first time, you now have to log in to each account individually—when prompted, allow your password manager to save the password in its vault. Next, locate the section where you can update your password—typically under "Account" or "Settings." Use the password manager's random



Click each below to see a full report of all the logins and passwords stored in your LastPass vault.
On supported websites you can change the password in one click, and you can check more than one to change multiple passwords at once. For other website, use the 'launch' option to go to the website, login, and use the LastPass Password Generator to replace the account's password.

Website and Username	Password Strength	Last Changed	Action
dropbox.com	0% - •••••••••••	3 years ago	Launch Site
Apple ID [redacted]	0% - •••••••••••••••	4 years ago	Launch Site

Identify and update exposed and weak passwords with LastPass's Security Challenge.

password generator tool to create a new random password—the longer the better. Use a mix of upper and lowercase letters, numbers, and (if allowed) symbols. In short, make it impossible to remember. Copy this to the clipboard, and paste it into the new password fields, before updating your password.

If you're lucky, your password manager detects the change and offers to update your password automatically. If not, log out and back in, pasting the new password over the old one in the login box. In most cases, your password manager detects the change and offers to update it; if not, open your password vault, click "Edit" next to the account, and paste in the new password.

Most password managers record your password history—this will be of use going forward should your password change not be registered, and you're forced to revert to the earlier password to log back in. As you go through your accounts, you'll probably come across some that are effectively dormant or no longer required. Rather than update a password you no longer use, consider deleting the account completely.

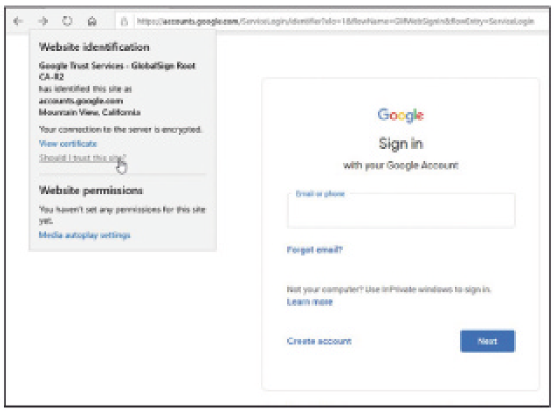
If you've been using a password manager for months, most of your logins will have been recorded. Now is the time to use the manager to identify and update weak and compromised passwords. 1Password offers its WatchTower reports in its Windows app, as well as online; LastPass and BitWarden must log on to their vaults through the web. From here, LastPass users should choose "Security Challenge" on the left—click "Show My Score," re-enter your master password, then go through the results. LastPass's Chrome extension even supports updating your passwords in batches to save time. BitWarden Premium users will find a selection of reports highlighting problems under "Tools."

EMERGENCY ACTIONS

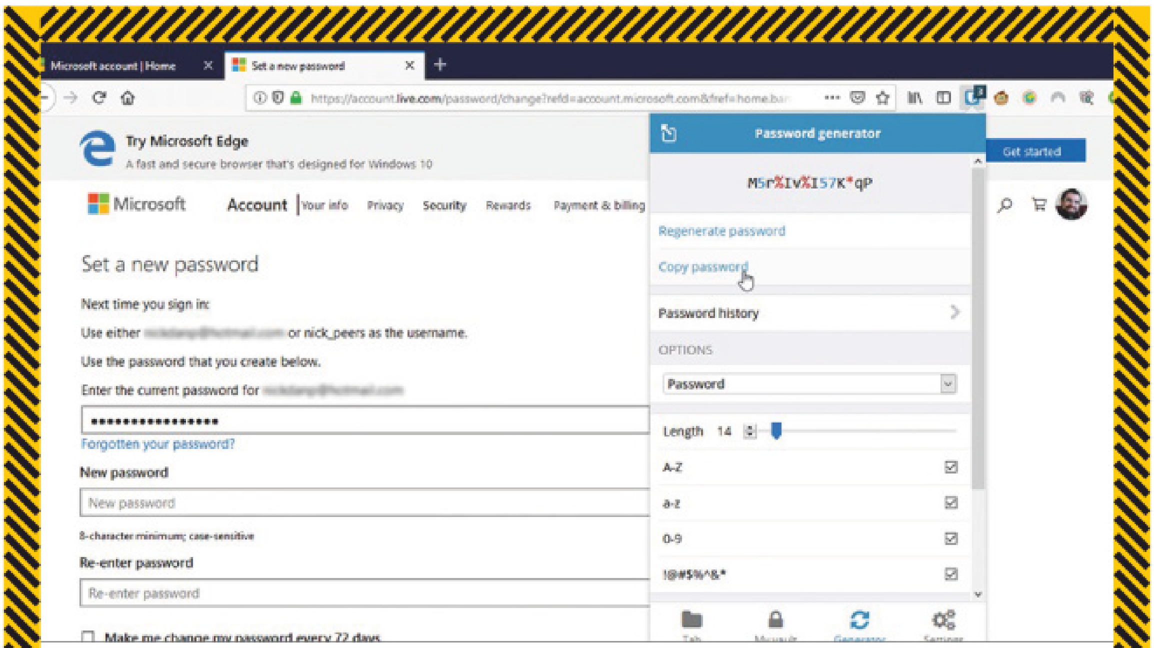
The above is all well and good, but what happens if you get locked out of an account? If you receive such a warning by email, don't rush to click any links in it, as they might redirect you to a facsimile of the genuine website, capturing any details you enter to hack your account. Most browsers and good security suites spot obvious scams a mile off, but check manually anyway.

Visit the site in question by typing its address into your browser. Verify the address is genuine by checking the URL in your browser's Address Bar, and by clicking the lock next to it. If you've been redirected, this indicates your PC's security may have been compromised—read up on previous articles on how to disinfect your PC. If you have access to a second PC you trust and know is clean, use it to secure your accounts before investigating the possible infection on your main PC.

If you're happy the site is genuine, log in, change your password, and look for options to add 2FA. If you find yourself locked out, start by trying a simple password reset—most services offer this. Enter your account email address, and an email will wing its way to that account. If you're happy the request is genuine, this is the one time you do click the link in the email, but double-check you're on the right site. Again,


Website identification
Google Trust Services - GlobalSign Root CA-R2
has identified this site as
accounts.google.com
Mountain View, California
Your connection to the server is encrypted.
View certificate
Should I trust this site?
Website permissions
You haven't set any permissions for this site yet.
Media autoplay settings
Google
Sign in
with your Google Account
Email or phone
Forgot email?
Not your computer? Use InPrivate windows to sign in.
Learn more
Create account
Next

Check a site is genuine before you log in.


Microsoft account | Home
Set a new password
https://account.live.com/password/change?refd=account.microsoft.com&fref=home.ba
Try Microsoft Edge
A fast and secure browser that's designed for Windows 10
Get started
Microsoft
Account
Your info
Privacy
Security
Rewards
Payment & billing
Password generator
Regenerate password
Copy password
Password history
OPTIONS
Password
Length
A-Z
a-z
0-9
!@#$%^&*

Set a new password

Next time you sign in:

Use either [redacted] or nick_peers as the username.

Use the password that you create below.

Enter the current password for [redacted]

••••••••••••••••

Forgotten your password?

New password: New password

8-character minimum; case-sensitive

Re-enter password: Re-enter password

☐ Make me change my password every 72 days

M5r%Iv%I57K*qP

Length 14

A-Z ☑

a-z ☑

0-9 ☑

!@#$%^&* ☑

THE PERFECT PASSWORD

*The days of securing your online accounts with short, easily guessable passwords are long gone, but what constitutes the perfect password? Is it using random characters, the password length, or a combination of both? Let's start with characters. Typing "nick" as your password is clearly weaker than "*I3G" because "nick" is easily guessable, particularly if it's your first name.*

*But guess what? A longer—but memorable—passphrase such as "ILoveTheFourthOfJuly" is potentially stronger than "*I3G" because while the passphrase might be guessable, it's more resistant to brute-force attacks, which just run through every possible combination of characters to try to arrive at the correct password. Shorter passwords are therefore easier (and quicker) to crack, as there are far fewer possible combinations.*

That said, passphrases are vulnerable as they tend to be reused—if not by you, by others. If a password is exposed because a site's usernames and passwords are compromised, those passwords can be used before employing the brute-force method, rendering the password useless for everyone—not just those who originally used it.

That's why password managers are essential. They allow you to generate long, random passwords that are impossible to remember or guess, and tie up brute-force attacks for months or even years. By that point, the site in question should be aware it's under attack, and take counter-measures.

It's different for your password manager's master password; you must remember that. The trick is to use a system to create a long alphanumeric password (with symbols) that only you can remember. For example, "!Eye'Luv#The$4h%0F^July." Pair it with 2FA and a cryptic password reminder (in case you need a subtle prompt), and your passwords will be as secure as they can be.

after updating your password, enable 2FA if it's offered.

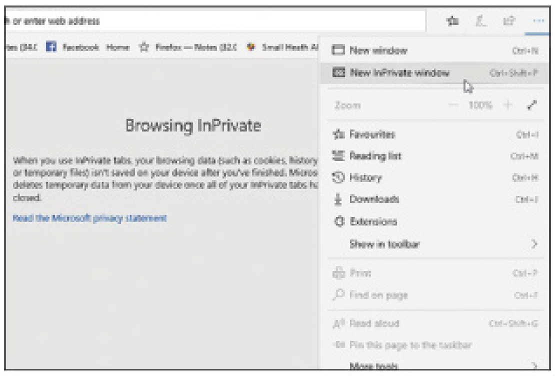
If you've not requested a password reset, this might indicate someone has got access to your email account. All web-based accounts worth their salt support 2FA, so if you've enabled this, you should be fine; otherwise update your password, and switch it on.

If you've been locked out of your email account, you're relying on one of two things: that you set up a secondary email you can use as a recovery address to reset your password, or that you can prove who you are using other means. Google, Microsoft, Apple, and other major sites have detailed recovery procedures that allow you to answer certain questions using personally identifiable information. Facebook allows you to nominate a trusted friend to take back control of your account. Again, make sure you're on the genuine website and not a spoof.

This process also relies on the fact the hacker hasn't changed your personal information to prevent you from gaining access. You need to consult your email provider's support pages for specific advice if you're unable to get in (search for "hacked," "recovery," or "password reset"). Be prepared to make contact by phone if it's available.

Once you've regained control of the account, log in to the associated email, and check the inbox, sent, junk, and trash to see if the hacker has left any traces of what they've been up to—including other accounts they've targeted. You may even see spam or infected messages have been sent to your contacts—you'll need to alert them if this is the case.

If you think you've been the victim of identity theft—typically revealed by unusual transactions in your financial records—visit one of the credit score providers, such as Equifax (www.equifax.com) or Experian (www.experian.com), for the steps to follow; usually ordering a copy of your credit reports and filing an initial fraud alert. Contact the police, too, and speak to your credit card provider and bank.



Browsing InPrivate

When you use InPrivate tabs, your browsing data (such as cookies, history or temporary files) isn't saved on your device after you've finished. Micros deletes temporary data from your device once all of your InPrivate tabs ha closed.

Read the Microsoft privacy statement

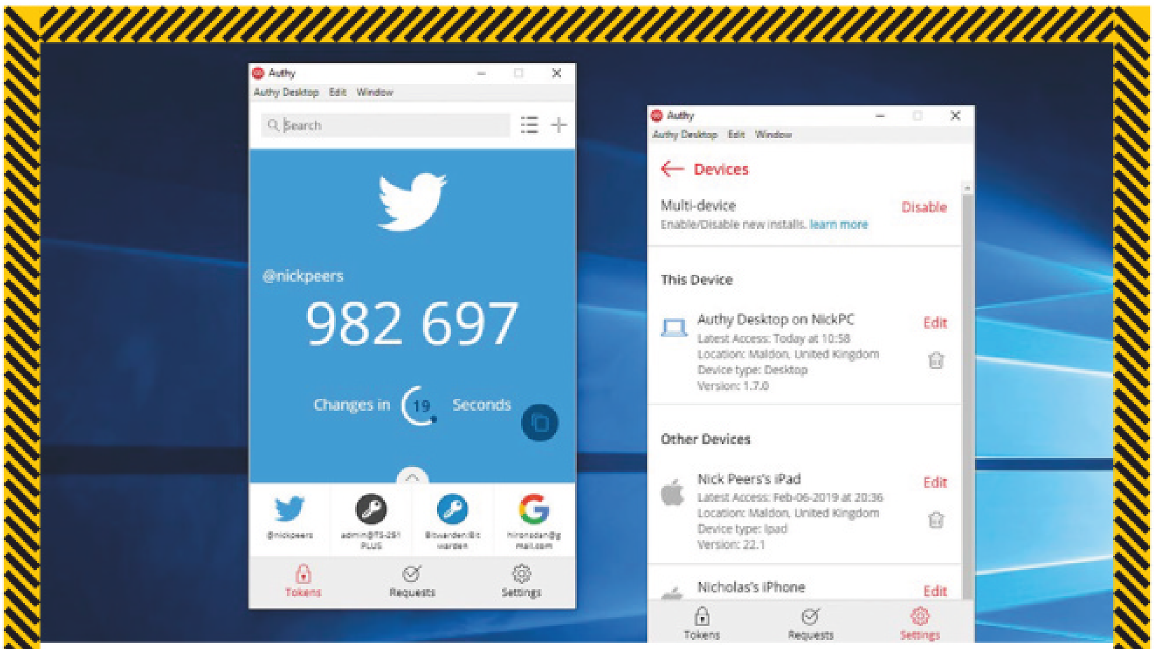
Check for breaches in a private or incognito browser window.

STAY SAFE GOING FORWARD

Once you've fixed your problems and ensured your accounts are protected by up-to-date passwords, you're done, right? Not quite. It's time to take a more proactive approach. First, don't worry about changing your passwords every six months as conventional wisdom dictates. Your passwords are no longer easily guessed, and brute-force attacks won't reveal them anytime soon.

That said, it might be wise to change the password every year, particularly on accounts where no 2FA protection is available—reports like Have I Been Pwned are based on old data, so you can't assume you're safe until your password manager alerts you. We also suggest you update your master password more regularly—every six months, say. Look for an option to rotate your encryption key at the same time.

Otherwise, follow the usual good-practice tips: Enable 2FA where you can, keep a tight lid on your PC's security, following advice in previous issues, remain vigilant against scammers—most hacks are now instigated through trickery—and above all, don't panic! ⏻



Multi-device
Enable/Disable new installs.

This Device

Authy Desktop on NickPC
Latest Access: Today at 10:58
Location: Maldon, United Kingdom
Device type: Desktop
Version: 1.7.0

Other Devices

Nick Peers's iPad
Latest Access: Feb-06-2019 at 20:36
Location: Maldon, United Kingdom
Device type: Ipad
Version: 22.1

Nicholas's iPhone

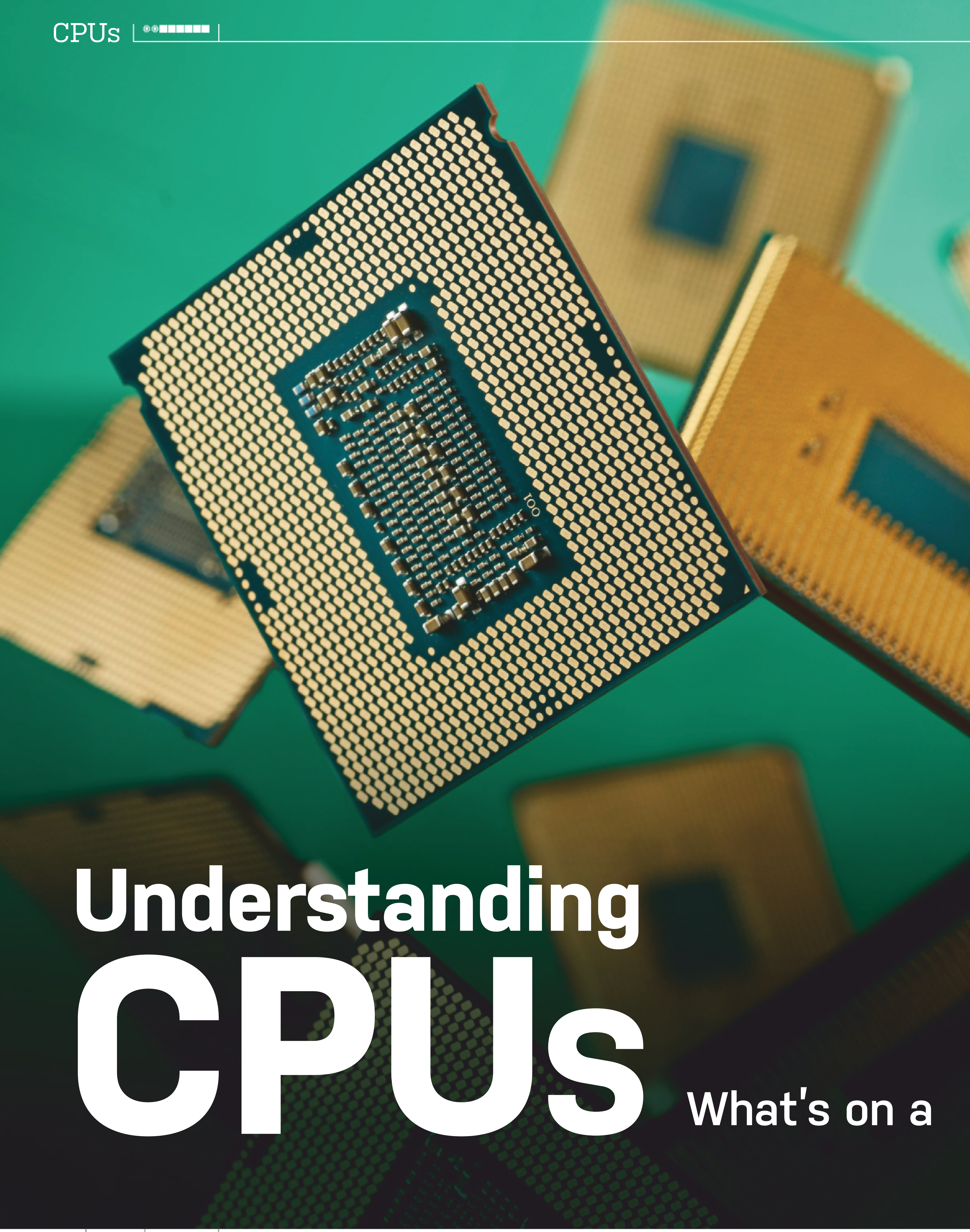
AN EXTRA LAYER OF PROTECTION

You can practically eliminate the threat from a brute-force attack, but you can't stop passwords being exposed as part of a wider security breach due to mistakes or weaknesses on the part of the online service holding your data. So, how do you take steps to protect your account in the event of such an attack?

The answer lies in 2FA, or two-factor authentication. This introduces a secondary requirement to the log-in process: a six-digit code you need to enter in addition to your password. The code changes regularly, and can be delivered via email, text message, or authenticator app. Email is the least secure—what if your account is compromised?—while authenticator app and text are preferable because they require your cell, a separate device outside the hacker's control.

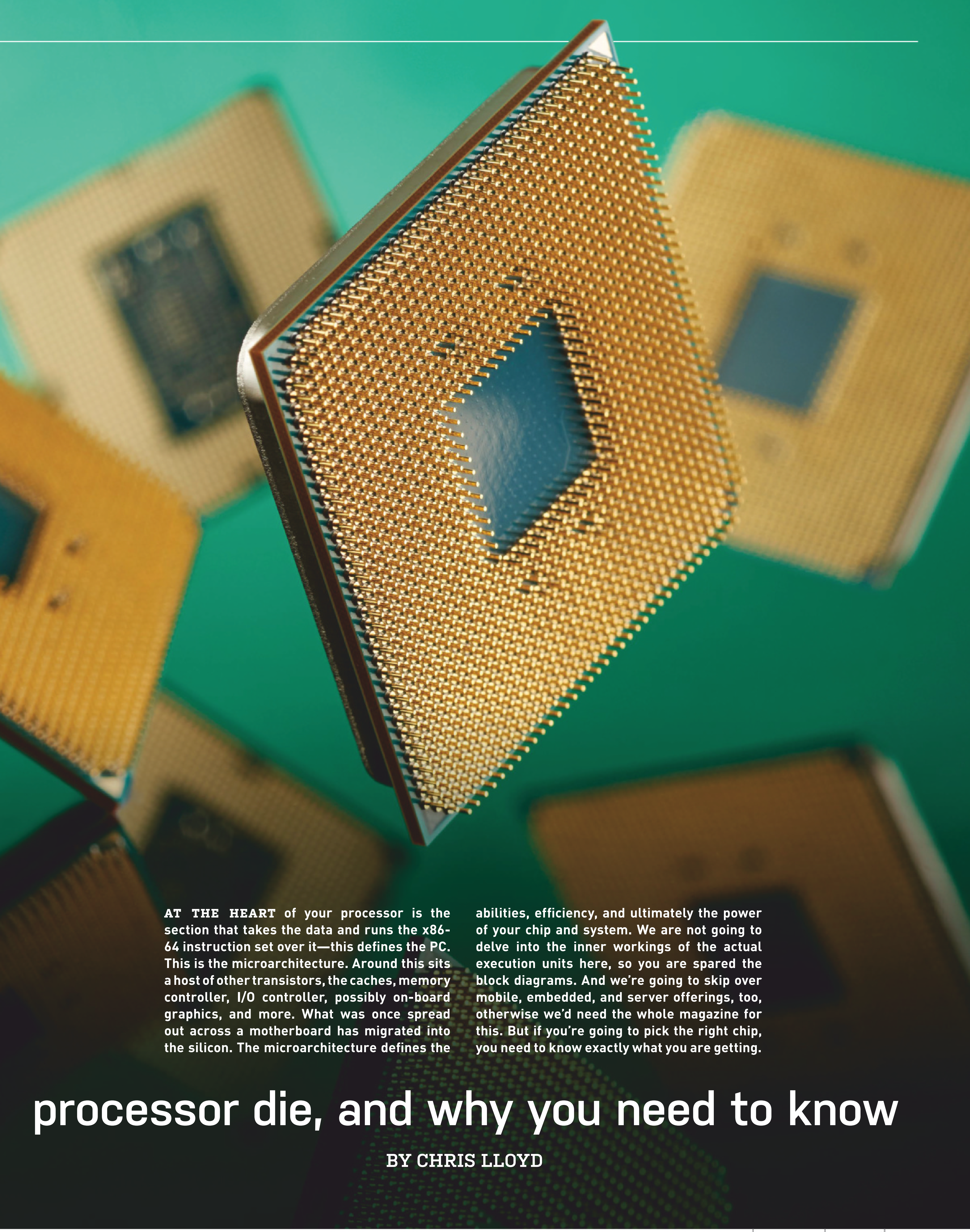
Text messages require a cellular network—codes tend to change every five to ten minutes—but authenticator apps work offline, and the codes change every 30 seconds, which is obviously more secure. Numerous systems and apps exist, but we recommend Authy (www.authy.com), which can be used on more than one device for convenience.

After installing and setting up the app, log in to your online account, and look for a setting to enable 2FA. If it's offered, choose the option to receive codes by app or Google Authenticator if it's name-checked. You can either type in the lengthy code manually, or scan the uniquely generated QR code into Authy using your phone's camera. Enter the six-digit code to verify everything's been set up correctly, and you're done. Just open the app—which can be passcode-protected for additional security in case the phone is stolen—whenever you're prompted to enter a 2FA code to log in.



Understanding CPUs

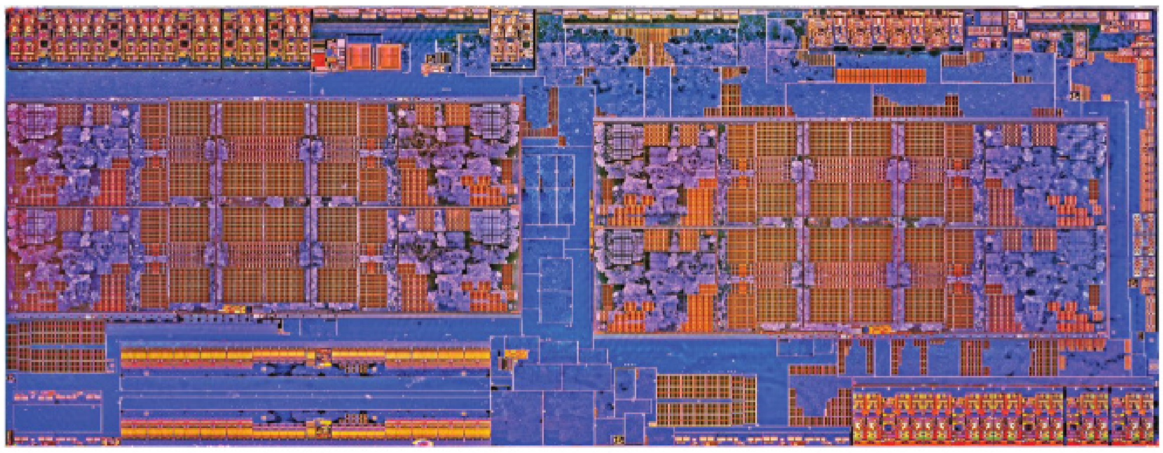
What's on a



AT THE HEART of your processor is the section that takes the data and runs the x86-64 instruction set over it—this defines the PC. This is the microarchitecture. Around this sits a host of other transistors, the caches, memory controller, I/O controller, possibly on-board graphics, and more. What was once spread out across a motherboard has migrated into the silicon. The microarchitecture defines the abilities, efficiency, and ultimately the power of your chip and system. We are not going to delve into the inner workings of the actual execution units here, so you are spared the block diagrams. And we're going to skip over mobile, embedded, and server offerings, too, otherwise we'd need the whole magazine for this. But if you're going to pick the right chip, you need to know exactly what you are getting.

processor die, and why you need to know

BY CHRIS LLOYD



AMD's Zen arranges its cores into CPU complexes, or CCXes. Here there's two with four cores each. Between them sits the L3 cache, shared between each CCX.

What microarchitecture do you have? Simple question, but the names given to processors don't help. For example, Intel's full name for the Core i7-8700 is the 8th Generation Intel Core i7-8700. Let's break that down. "Core" indicates that the basic architecture is based on Intel's multicore processor model. So, what's an "8th Generation" chip? Intel has loosely divided its Nehalem Core chips into generations. Nehalem was actually the third Core architecture, the first ones being Core and Core 2. Then it decided to go back to the brand name Core, and when it thinks it has made significant improvements, Intel blesses the chips with a new generation. There are no rules really, so it's just an indication of how new the design is. 8th Generation chips generally have more cores than 7th Generation ones; other than that, they're pretty much the same, bar some cache and memory bumps. The latest 9th Gen desktop chips have hardware protection from the Meltdown and Spectre vulnerabilities, and little else.

The "i7" part of the name is pure marketing; it indicates nothing more than that Intel considers this chip to be toward the high-end. The "8700" also equates to little more than where it stands against Intel's other chips. The name may help place a chip into a marketing scheme, but tells you little else. The i7-8700 is a Coffee Lake chip. This defines the starting parameters of what it can do, but you have to dig around in the specifications to find out exactly what you're buying.

Coffee Lake is a refinement of Skylake—Intel's code names can get confusing. Skylake is the microarchitecture design, the fundamental part that does the number-crunching. This has been through two major revisions, which get their own separate code names. 2016's Kaby Lake was a refinement of the design, dubbed the 14nm+ process. It also got some useful hardware video encoding/decoding extras (Intel has a dedicated video processing unit called Quick Sync Video, which handles encoded video streams), and support for USB-C and Optane. In the fall of 2017, we got Coffee Lake, a further refinement using a 14nm++ process. Performance inside the cores remains pretty much the same across all these iterations.

In the X-Series, you'll find Skylake-X and Kaby Lake-X cores for HEDT systems, with up to 18 cores, and $2,000 a pop. There are some oddities still available, too, such as the Intel Core i7-5775C, which is based on the 5th Generation Broadwell core. Somebody must still want this for some reason we can't fathom.

Intel basically produces one main desktop processor architecture—it has been shrunk, optimized, had cores added, and cache changed, but at its heart, Intel's desktop chips have shared a common design heritage since 2015: Skylake. AMD has its Zen architecture, launched in the spring of 2017, Zen+ being an optimized version. So, there are just two main desktop microarchitectures,

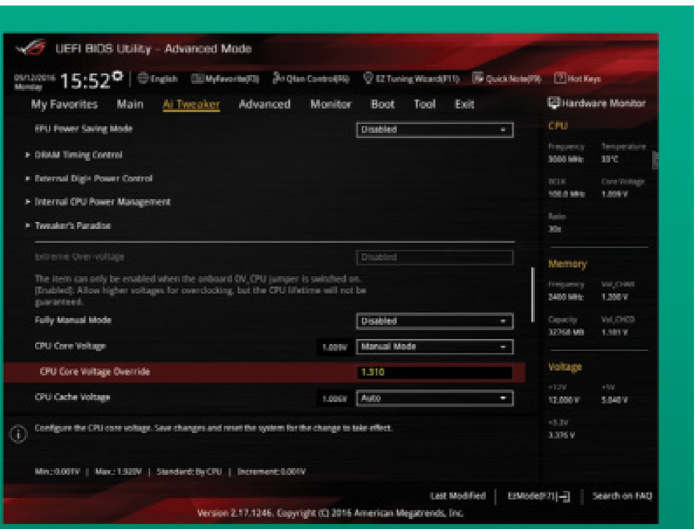
HOT TOPIC

There is a practical limit on how much heat a chip can handle before going pop, and keeping cool is a fundamental part of processor design. The goal is more performance per watt. Thankfully, chips don't go pop anymore, either; there are sensors and systems that throttle back or close down a chip if it gets too hot. Overclocking used to be potentially a rather expensive practice....

A figure attached to every processor is its Thermal Design Power, or TDP. This is supposedly the most heat it can generate, for which you have to allow cooling, measured in watts. Only it isn't. Under heavy loads, and with boost engaged, it will sail past this figure, by 150 percent or more. Actually, you can make it do this all the time if you delve into the BIOS and set the power limits to silly numbers, so boost modes stay on indefinitely.

TDP is now configurable by the system, cTDP—if it senses higher levels of cooling, it turns up the heat, or vice versa. Exactly how a single TDP value is calculated from all this is a bit of a mystery. Chips have different safety margins and responses to thermal loads anyway. But, as it's a hard number, it is used as a point of competition between Intel and AMD in their marketing, despite the fact that it is not directly comparable. Intel went as far as inventing a new measure, Scenario Design Power, which, you may have guessed, reports a lower figure than TDP. AMD used to use its Average CPU Power figure, again a lower number.

TDP figures are really a guide as to how much cooling you need above anything else. If it's 100W or so, then you know you need a big chiller. What a chip draws in action is another matter, because there are so many variables at play—low TDP chips may still idle high, while high TDP ones may drop right down while not doing much. Take the quoted figures with a pinch of salt; they're a guide only, and if in any kind of doubt, fit a bigger cooler— it can't hurt.



EPU Power Saving Mode: Disabled

DRAM Timing Control

External Digi+ Power Control

Internal CPU Power Management

Tweaker's Paradise

Extreme Over-voltage: Disabled

The item can only be enabled when the onboard OV_CPU jumper is switched on. [Enabled]: Allow higher voltages for overclocking, but the CPU lifetime will not be guaranteed.

Fully Manual Mode: Disabled

CPU Core Voltage: 1.009V Manual Mode

CPU Core Voltage Override: 1.310

CPU Cache Voltage: 1.006V Auto

Configure the CPU core voltage. Save changes and reset the system for the change to take effect.

Min.: 0.001V | Max.: 1.920V | Standard: By CPU | Increment: 0.001V

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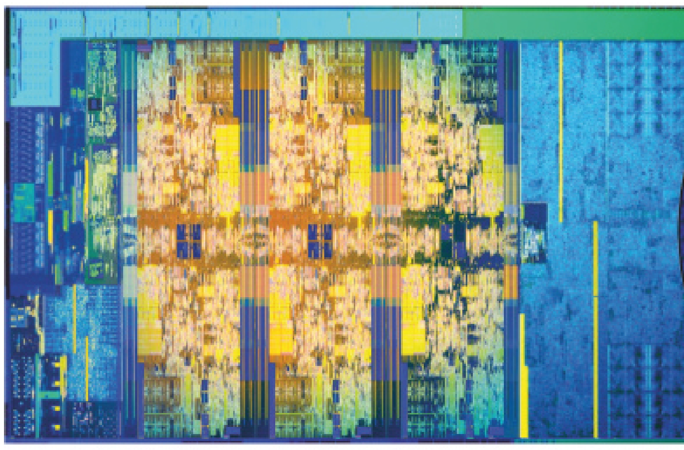
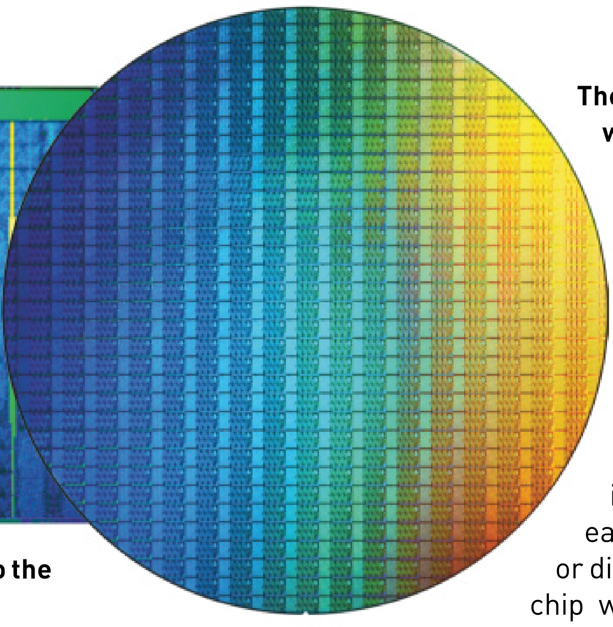


The Coffee Lake die—eight cores in the middle, GPU to the right, and the rest spread around the edges.



The whole enchilada, a Coffee Lake wafer as it comes from the foundry, ready to be cut up and tested.

despite the profusion of names, versions, generations, and marketing numbers.

To make a family of chips out of one design, Intel changes the base clock, core count, memory speeds, whether Hyper-Threading is enabled, how much L3 cache you get, whether it is overclock locked, and what Turbo Boost rates it has. Juggling these is how Intel can sell 24 desktop CPUs out of one Coffee Lake microarchitecture, under brands from the Pentium (it's still going) to the Core i9.

Tick-tock-toe

Intel once followed a production model called the tick-tock cycle. The "tick" was a die shrink, and refinement of a design. The "tock" was a new microarchitecture. The original Core architecture was quickly followed by a die shrink, and so on, through a confusing number of code names. Things ticked and tocked along nicely until problems with the 10nm process left Intel going "tock" twice. It then announced it had a new model, process-architecture-optimization, where it follows a die shrink with a new architecture, which it then optimizes. Then it had to go "tock" again with Coffee Lake. The first round of the new model is due to be Cannon Lake (the shrink to 10nm), followed by Sunny Cove, then Tiger Lake. The first 10nm chip is on sale, though you'd be excused for not noticing. It's a Core i3-8121U, and only currently available in one model of Chinese laptop.

Back in day, it was all about clock speeds. The faster a chip, the better it was at everything. Early progress was rapid, from a 66MHz Pentium in 1993 to a 1GHz Athlon by 2000. The Pentium 4 was found to be stable at 4GHz in 2004. Then things stalled. It has taken years to reach 5GHz—physics gets in the way. Every time you switch a transistor, it generates heat. Make them small, and switch them rapidly, and you can create more than you can dissipate. One solution to this is shrinking the die, making all those transistors smaller, so you can lower the voltage. This has a whole other set of problems, too, not least of which is that the lasers used in lithography are thicker than the features you want to cut.

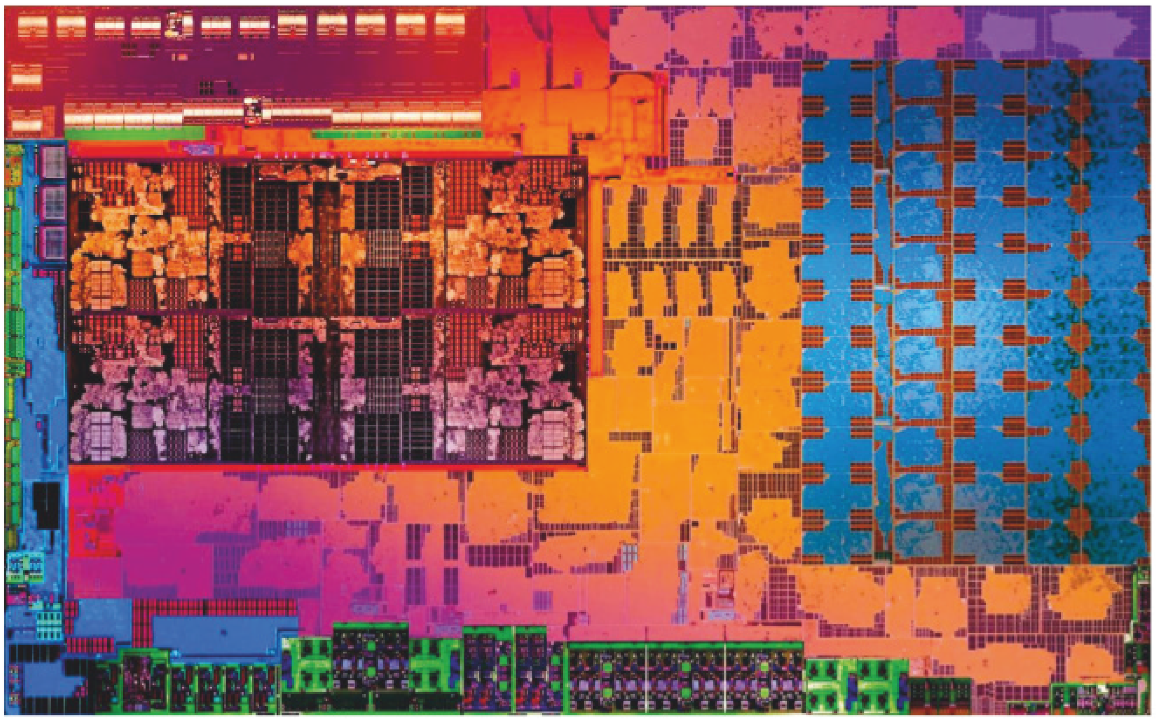
Intel's Pentium 4 was the turning point. It had long, convoluted pipelines, and consumed a lot of power. It could reach impressive numbers when liquid cooled, but was a design dead end. So, Intel changed direction, and its Next-Generation Microarchitecture, or Core, was born. The answer was short pipelines, higher efficiency, plus multiple cores. Initially, clock speeds were lower than the P4, but soon matched and surpassed it. The Core chips had up to two cores, while the Core 2 had up to four (the use of Core as a brand name can get confusing, too).

The Pentium 4 did have one feature that was carried over: Hyper-Threading, or HT. This is a Simultaneous Multi-Threading system, or SMT. For each physical processing core on the chip, the operating system addresses two logical ones, and shares tasks between them. Modern chips are superscalar, so they can work on multiple instructions in a single cycle of the clock. For example, complete a floating point and an integer calculation in one click. HT takes advantage of this. As far as Windows knows, it is addressing two separate cores, each one individually fed data, halted or directed elsewhere. Thus a four-core chip with HT can run eight threads, or tasks, at once. It works extremely well: The close sharing of resources—both threads have access to exactly the same—can work in its benefit, or occasionally cause contention. AMD has almost exactly the same technology, called simply Simultaneous MultiThreading.

Core strength

Pure computational power is how many instructions you can run in a given time: the IPC, Instructions Per Cycle, times the clock speed. Clock speeds may have stagnated, but IPC numbers per chip are jumping rapidly as cores are added. There are theoretical numbers, simply multiplying threads and cores, but in practice these are never reached. How the application is optimized is paramount—multicore designs need multithreaded software. To get a significantly better IPC per core, and increase the overall efficiency of the whole family in all configurations, you need a new microarchitecture.

At this point, we move to AMD. It had been struggling for years to match Intel at the high end. It never had the investment



AMD's Raven Ridge—that big blue block is an RX Vega graphics engine, which, unlike Intel's on-board graphics, makes a fair go of gaming, albeit on a budget.

INTEL® CORE™ i7
i7-6700K
SR2L0 4.00GHZ
X611A978 e4

An Intel Core i7-6700K, the original Skylake halo chip from 2015. This is still a capable CPU, despite being only a 6700—its base clock is 400MHz faster than an i9-9900.

to fully develop its chips, and always seemed to be the budget alternative. It had followed Intel's path to producing complex designs, and similarly started with a fresh multicore approach. Its Zen architecture is cleaner, more efficient, and had up to eight cores. This was rapidly followed by Threadripper, a ludicrously big chip for a desktop, with 16 cores. If it's all about the core count, AMD is winning.

Simply adding cores is no guarantee of performance, of course. In the worst case scenario, your fancy eight-core machine is running software that simply hammers one core. However, if you have idle cores, it also means you have spare thermal dissipation. It's safe to run some cores above specification, because they're next to idle, and therefore cold, cores. Turbo Boost does this (or Turbo Core, if you are AMD). When software demands the highest performance possible, via the ACPI (Advanced Configuration and Power Interface), the processor overclocks selected cores, and lets others idle. This is how Intel's Core i9-9900K can reach the magic 5GHz: It is only running on two cores.

The upshot is that base clock speeds are no longer a reliable indication of performance. After years selling us better chips because they were "faster," with a number to prove it, the industry has yet to give us an easy metric to measure a chip's relative power.

Where single-core speed can still count is in games, which can be notorious for hitting single cores hard. Intel has traditionally had the top GHz numbers, which has resulted in Intel machines running most (but not all) games faster. This is changing. Clock speeds aren't going to increase anywhere like as dramatically as they have done in the past. It has taken more than a dozen years to go from 4GHz to 5GHz. There's no sign that 6GHz will be any easier. What we do have is more cores, and this is where programmers are going for more power. Running two cores at 5GHz on your i9-9900 leaves six cores (12 threads) doing nothing, potentially nearly three times the computational power. Boost rates give a nice headline number, but as applications spread out properly, they will start to become redundant.

***Battlefield V* chews through eight threads, if you have them; above that, it starts to level out. Good, but we need more, as 16-thread and better chips are not going to be uncommon soon.**

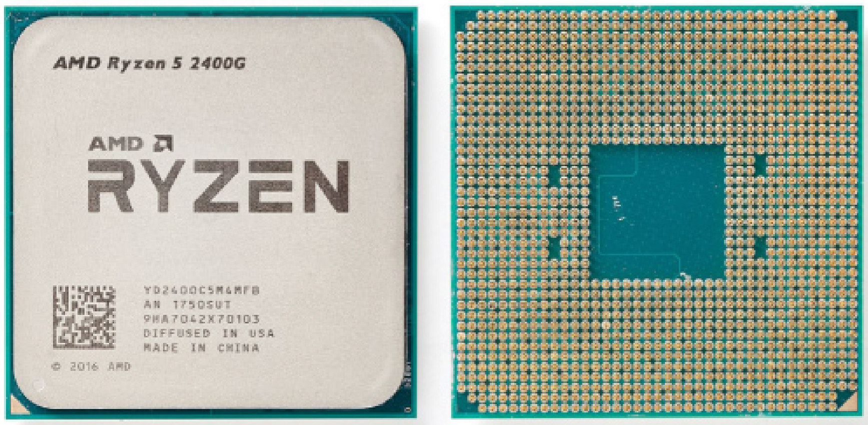
***Rise of the Tomb Raider* is one of new breed of games that can make use of multicore processors. As ever, software lags behind hardware, but it is catching up now.**

Cache phrases

All chips have a small amount of memory to store the data it is working on, this is the Level 1 cache. This sits right in the core, next to the registers: the final destination of data to be processed. A chip can only work at top speed if it is fed data as fast as it needs it. If the L1 cache can't be filled fast enough, it limits the speed of the processor. Fetching data from the main memory is far too slow. There are separate L1 caches for instructions and data, 32KB of each for Coffee Lake; Zen+ gets double that for the instructions. Cache sizes are quoted in KiB and MiB, which are the binary versions, just to avoid confusion, as KB can mean 1,000 bytes in some circles (which is why your hard drive is smaller than you expected).

Above this is a Level 2 cache. It used to sit on the motherboard, but is now on the same silicon as the processor. This is the main interface between CPU and memory; data copied to the L1 cache is also copied to the larger L2 cache, ready in case. Coffee Lake chips have 256KiB of L2 per core, Zen+ stretches this to 512. Above this sits the L3 cache, slowest and largest. It is the only cache that all cores can access freely, or blocks of core, in the case of AMD. This has also migrated to the CPU, but lives just outside the cores, and varies depending on which version of a chip you have—Coffee Lake has 1–3MB per core; Zen+ ranges from 2MB to 4MB.

Feeding the caches with the right data is a dark art. It's all about maximizing L2



AMD's Ryzen came as something of a shock. It was better than we expected, and Intel had some solid competition at last.

Intel's high-end desktop chip, the Skylake-X. If you need those chip-side PCIe lanes, this is what you want. Or if you really need 18 cores.

hits, and avoiding going beyond L3. This gets needlessly technical frighteningly quickly. Intel has its SmartCache feature, which enables unused cores to share their L2 cache. Another technique is worth a mention here: prefetching. This is where data that is expected to be needed is copied into the cache before it has been requested. Clever stuff. Unfortunately, it recently came unstuck, which required changes to the microarchitecture (see boxout below). Applications that run in tight circles hit the cache a lot, and a bigger one is a relatively easy way to squeeze more performance out of a design.

Memory controllers now live on the processor die, which makes sense, as the two are closely tied together. You can play around getting faster modules to work, assuming motherboard support. Some games appreciate the extra, and some folk just have to have the best. But when extensive testing puts the gains in the order of 1 percent, you can spend your money elsewhere to better effect. However, it is worth getting the fastest officially supported memory speed, and look for a low CL (CAS latency, a measure of internal latency in accessing specific memory locations; lower is better) if you want to squeeze out some extra. Unless you plan to overclock the bus, faster is generally a waste.

Changing channels

What about channels? This is old tech. Memory started struggling to supply enough data way back in the 1960s. These days, memory is so much faster that much of the benefit has faded away unless you are shifting huge amounts of data. A dual-channel controller adds another 64-bit bus to the memory, doubling the bandwidth. Each channel can be accessed separately by the processor, and requires matching modules: configured speed (modules can run at a number of speeds, not just the headline one) and capacity. However, both slots need not be populated, so you can run a three-DIMM dual-channel system if you put them in the right slots. Coffee Lake and Zen+ both offer dual-channel memory. Triple-channel is found in a couple of Intel's older i7s, while quad-channel appears on Threadripper and Skylake-X. High memory bandwidth

GHOSTS IN THE MACHINE

In the summer of 2017, two security vulnerabilities were discovered, which went public in January 2018, and caused something of a panic. Meltdown and Spectre, as they were dubbed, did something really nasty. The loopholes were in the very fabric of the microarchitecture, built right into whole families of processors, including every Intel one since 1995 (mostly). A nightmare for the chip makers. Both vulnerabilities exploit speculative execution, including branch prediction, which is as it sounds, where the processor works on data it hasn't been asked to yet, in the anticipation that it will.

Meltdown works because, as part of the speculative execution, prefetch cache data is not checked for permissions. This opens the door to malicious code getting executed, leading to cache data being open to be read—your password, for example. Spectre works in a similar way, enabling data within a speculative execution to be read. Essentially, they enable god mode: access to the kernel memory.

Have these two ever actually been used in the wild? Not really. A few "proof of concept" code snippets have surfaced, and not much more. An organized and targeted attack has yet to materialize. That doesn't matter—it has to be fixed. Software and BIOS patches were quickly deployed. The first Intel patches proved troublesome, causing crashes and, ironically, damage that the vulnerabilities hadn't managed. However, early reports of huge performance losses with patches proved unfounded.

There is a cost, though, depending on the task, of a percentage point or three, particularly on servers. However well the patches have worked, and they are getting better, this isn't going to go away. New variations of Meltdown and Spectre have been discovered, too—we are up to 27 in all.

The only real cure is a microarchitecture that properly seals the loophole. Intel's 9th Generation chips have such modifications, as will AMD's forthcoming Zen 2 (Spectre only, as its chips are immune to Meltdown).

ALL ABOARD

AMD Athlon 240GE
YD240GC6M20FB
AN 1849
9HG0268

Once upon a time, every PC needed a graphics card; now, many processors come with a decent one ready to roll. If you haven't used a processor's on-board graphics for a while, you may be pleasantly surprised—they are actually perfectly usable. Not top-title-games or productivity good, but for most other things, perfectly adequate.

Intel uses its UHD series in desktop chips—virtually all of them, in fact. All Coffee Lake chips, bar the Celeron version and those bizarre KF series, sport a UHD 630 engine. This runs at a base clock of 350MHz, and a slightly faster boost as you move up the pecking order, from 1.1GHz to 1.2GHz. It can handle a 4K screen, and can access a maximum of 64GB video memory (an unlikely scenario, because all this is all coming from your system memory).

You can game using the UHD 630, but don't expect 3D wonders. Hardened gamers and many reviewers have scoffed. However, if you occasionally use undemanding games, you'll be OK. It's recommended to stick to 1080p, although we have been playing older games at 1440p without too much trouble.

AMD has its own Radeon technology to plunder, so we can expect it to be good at this. In fact, this used to be AMD's strong point, with its Athlon APUs. However, AMD appears less keen at adding integrated graphics to its Zen range—the Zen+ is only coupled to graphics in the mobile APU chips. It does sell a couple of desktop Zen-based Ryzens with integrated graphics, though, code-named Raven Ridge, branded as a Ryzen 3 with an RX Vega 8, and a Ryzen 5 with an RX Vega 11 engine. Budget they may be, but their performance is tasty. The Ryzen 5 2400G sports 704 stream processors, and is good for 1080p gaming (on reduced detail at times, perhaps). For $170, you get both processor and graphics in one—difficult to complain at this price.

A separate graphics card is always going to be first choice, though. Intel's UHD is good enough at the desktop, but will struggle with anything demanding. Of course, it is effectively free. The Ryzen G series is another matter—these are decent budget gaming chips, and AMD is the one to watch here. Its forthcoming Zen 2 chiplet design leaves lots of room for a pokey GPU, although this is some way away yet.

produces some impressive raw benchmarks, but don't expect miracles in action—if the processor is busy, it adds nothing. It comes into its own when running memory-intensive content-creation apps and server work, but on more mundane tasks, there's not the huge gain the numbers suggest.

Do you remember EEC (Error Code Correction)? It was widespread when RAM modules weren't quite as reliable as they are now. You'll find support is still baked into older core designs, but you don't really need to bother unless you are running a mission-critical system, where a single failure causes a plane crash. You'll only find this on server systems now. If you did remember EEC, you can forget it again.

What else is on a processor wafer? Apart from general housekeeping jobs, there's one important bit left: the input/output block. Most I/O is handled by your motherboard chip—it runs the drives, USB, and whatnot. However, the processor does have a set of high-speed I/O, too, and Intel calls it just that: HSIO. On an Intel chip, these manifest as 16 PCIe lanes, which generally go straight to the first slot, ready for your graphics card. AMD's Zen+ claims to have 20 lanes, but four of these are used to connect the processor to the motherboard chipset. These lanes are precious, since they go direct to the CPU—no bottlenecks anywhere. On Coffee Lake, you can configure these as two x8 lanes, for your dual graphics cards (dropping to eight lanes each isn't much of a deal; there's a lot of bandwidth), or one x8 and two x4, to run NVMe. If you want more, you need specialist silicon. Skylake-X has 28 or 44 HSIO lines.

intel
CORE i3
8th Gen
intel
CORE i5
8th Gen
intel
CORE i7
8th Gen

At their heart, all these 8th Generation Coffee Lake chips run the same Skylake microarchitecture, as did the previous 7th and 6th Generation chips.

One final point: processors and motherboards come as a couple. Support for a feature on the chip requires support from the motherboard to implement. All the processor's external connections are under the control of the motherboard designer—they work as a couple, and need to be chosen as a couple.

What's next? Both the main players are about to release new microarchitecture designs, which should see a real rise in IPC power. AMD's Zen 2 will appear this year, ahead of a big push next year. Intel's Sunny Cove is also scheduled for 2019, although its record of hitting deadlines recently has been poor. This is a momentous move for Intel; it' s been using Skylake in everything for years. We are about to see a switch from competition between Skylake and Zen-based chips to Sunny Cove and Zen 2 ones. Things are going to get seriously shaken up, especially if the rumors about Zen 2 pan out. ⏻

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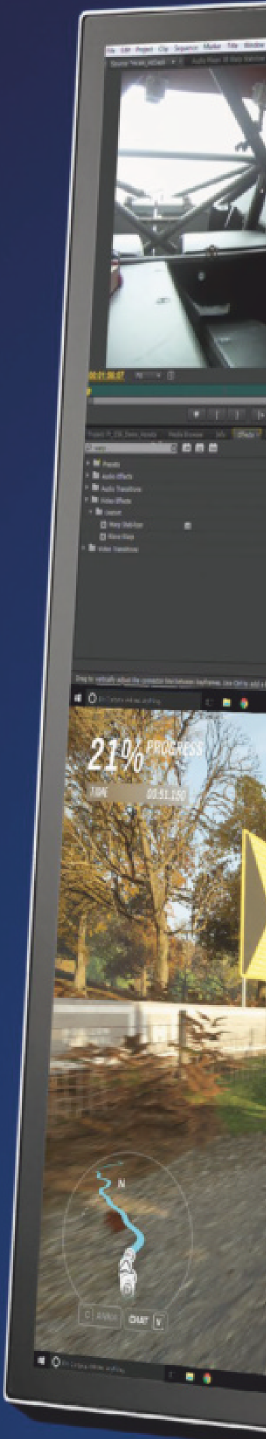
GET READY FOR 8K



It was wall-to-wall 8K TVs at CES this year. 8K is almost certainly headed for the PC, but should we welcome it, wonders *Jeremy Laird*

BIGGER IS BETTER. Eight is twice as big as four. Therefore 8K video must be twice as good as 4K. Not convinced? Just ask *Maximum PC's* intermittently innumerate editor Alan Dexter. He'll set you straight. Would that it were so....

8K is, of course, four times as big as 4K when it comes to the number of pixels on offer. But that isn't the point. It doesn't help us get at the underlying question that the very existence of 8K video raises. Is increased resolution necessarily better? More specifically, is there any upside in stepping up to 8K from 4K? After all, 4K offers over eight million individual pixels. Could 8K's 33 million pixels be overkill?

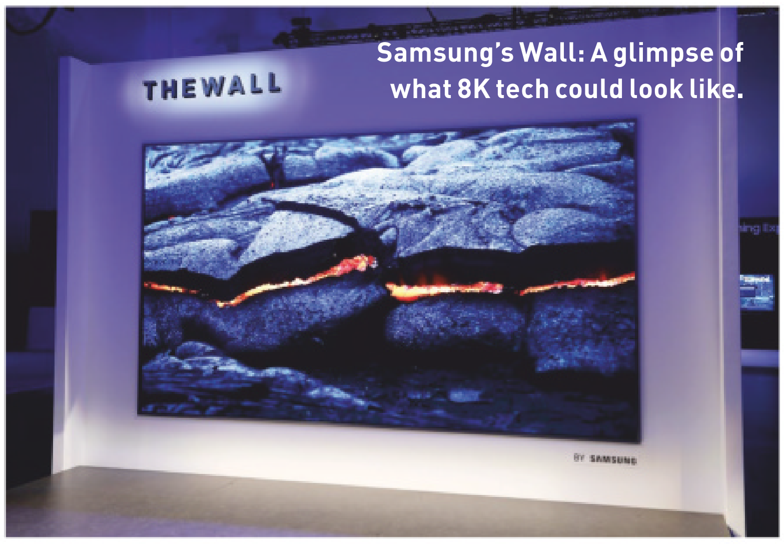
Likewise, what's the point of 8K if there isn't any 8K content? Even 4K content is hardly ubiquitous. 8K content barely exists. Not that display makers seemed worried about that at CES in January. Admittedly, not many of the 8K wonders at CES were PC screens, but where HDTVs go, mainstream PCs surely follow. Thus, the PC adopted 1080p and then 4K from TVs. Next it will almost certainly be 8K. For sure, PC monitors and laptop panels are more varied than that, what with superwide monitors ever more popular on the desktop, and some laptops opting for taller 3:2-aspect displays. But what goes for HDTVs usually becomes default for the PC. Make no mistake, 8K is coming.

For the record, 8K typically refers to a pixel grid composed of 7680x4320 pixels. 8K is therefore four 4K pixel grids, just as 4K was a quadrupling of 1080p. In other words, in a relatively short space of time, the display industry has moved from the two-and-a-bit million pixels of 1080p to the 33 million of 8K. That's a 16-fold increase in pure resolution. Staggering.

The question that follows is whether the benefits are visible. Isn't 4K enough? With any display, there's a point at which the human eye can no longer resolve additional detail. Apple popularized this notion with its "Retina" displays, the idea

RECENTLY ADDED MUSIC
MY NEWSCAST
27 M
CHECKPOINT
POSITION 3/12
MurkyCat8967600
UBER
DELL

Dell's 8K monitor is expensive and flawed, yet breathtaking.



Samsung's Wall: A glimpse of what 8K tech could look like.

IS MICROLED THE ANSWER?

Shining a big backlight—or a huge number of individual backlights—through a grid of millions of tiny, imperfect shutters is a silly way to go about engineering large-format, full-color displays. But that's LCD monitors for you. With that approach, contrast and viewing angles will always be a problem. Ditto pixel response.

Admittedly, LCD tech has improved dramatically, but it will always be suboptimal for this application. For smartphones and some HDTVs, the alternative to LCD is increasingly OLED, or organic LED technology. The main upside is that each pixel is its own light source, so "off" really means "off," and the achievable contrast is therefore essentially infinite. But OLED comes with its own problems. It too suffers from off-axis image quality issues. More troublesome is burn-in, which is particularly worrisome when you have persistent screen furniture. Like the Windows interface.

An even better solution looks to be microLED. It's similar to OLED, but doesn't rely on organic materials, so it doesn't suffer from burn-in. It also offers near-perfect viewing angles and the same infinite contrast of OLED. So far, difficulties in reliably manufacturing the tech has prevented microLED from hitting the mainstream. Engineering-wise, it's also problematic shrinking the required circuitry small enough to allow for high-resolution displays. But heavy hitters such as Samsung and, reportedly, Apple are working hard at making the technology suitable for mass production.

Samsung showed off its latest microLED tech at CES in January, and the image quality is absolutely staggering. It showed a new version of its microLED "Wall" this year, now measuring 219 inches. Made up of modular microLED that can theoretically be combined to create a display of almost any size or shape, the resulting display is absolutely bezel-free, and on the scale shown at CES, it's like looking through a huge window, the image quality is that realistic.

OLED has been slow to make the jump from HDTV to PC, where the problem of burn-in is even greater, due to things like Windows. Seeing how microLED is beginning to ramp up, we wouldn't be surprised to see it make it big on the PC before OLED gains momentum. An 8K microLED display would pretty much be the ultimate endgame for conventional flat-panel displays.

being that any Apple display worthy of the "Retina" tag ought to be able to match or exceed the visual acuity of the human eye's retina. It's the point at which you can no longer make out individual pixels.

DISTANCE LEARNING

Defining what that means in practice is tricky. It depends not only on the pixel pitch of the display, but also how far away it is. Stand 20 feet away from a 1080p 15-inch laptop screen, for instance, and there's zero chance of making out the pixels. From a foot and a half away, it's a whole different story.

Handheld devices, such as phones, are subject to the closest visual scrutiny. Hence, even a cheap smartphone now offers 300 or more pixels per inch. At the other end of the scale, TVs are viewed from much larger distances. So, the apparent pixel pitch for any given actual pixel pitch on a TV viewed at a distance can be comparable to a smartphone. PC monitors fall somewhere in between. Let's put some numbers on that.

One way to think of it goes like this: Imagine viewing a 30-inch 8K monitor from precisely one foot away. Its pixels look precisely the same apparent size as a 1080p monitor viewed from four feet. That helps to illustrate the idea that viewing distance is critical.

But it's how that distance maps to the acuity of the human eye that matters. The standardized notion of "normal" human vision, sometimes known as 20/20 vision, dictates that the human eye can resolve details down to one sixtieth of a degree of arc. On its own, that doesn't tell you much, but you can use it to calculate the distance at which the pixel pitch of a display matches the acuity of human 20/20 vision, and thus achieve what Apple referred to as the Retina display.

For instance, take a 15.6-inch 1080p panel of the kind often found in gaming laptops. That works out to 148 pixels per inch, and you'd need to view it from two feet away for the pixel pitch to map more or less to 20/20 vision. A 40-inch 4K monitor? That's 110 pixels per inch, and you'd need to view it from a little over two and a half feet to achieve the same effect. It's worth using a tape measure to check those distances if you want to really get a feel for all this. Two feet is probably further than you think. More to the point, it's further than most people put between their eyes and a laptop screen.

We all know and understand this instinctively. Every tech head will be aware, for instance, that the fonts on their smartphone look crisper and sharper than those of their PC monitor. For the standard 4.7-inch screen in the iPhone 6 to 8 series, the visual acuity distance is about one foot. That's a little closer than you normally hold your phone, but the two feet required by the 1080p laptop screen is further than you'll likely choose to hold your cell.

The question is where 8K fits in, and how it compares to 4K. How big must an 8K display be before you get a benefit? Remember that 40-inch 4K panel, and its slightly-more-than-comfortable 2.6 feet required to match 20/20 vision? The distance drops to just under 1.5 feet for an 8K panel of the same size. Boom! On a 40-inch panel, 8K makes a difference at normal PC monitor viewing distances.

POINTS OF VIEW

But what about a 32-inch panel? At 4K, you're looking at a viewing distance of two feet to achieve Retina-style visuals. That's slightly further than the 21–22 inches this particular author puts between eye and screen. 8K at 32 inches, meanwhile, works out to just over a foot to line up with 20/20 vision. You could argue that's overkill. 6K would probably be sufficient for a 32-inch panel. But the main point is that you can see the difference between 4K and 8K on a 32-inch panel at normal viewing distances. We know, we've seen it.

All this assumes normal human vision. Some will have better vision; others worse. But the lesson is that the advantage of 8K over 4K in a PC monitor is restricted to fairly large displays. As a rough rule of thumb, the benefits of the jump from 4K to 8K fall off rapidly with anything smaller than 30 inches. Conversely, as you move up in screen diagonal beyond 30 inches, 8K becomes more and more worthwhile.

Before we consider some of the other technical issues around 8K, let's slap the question of 8K content over the sideline. It's true there isn't really any 8K content. It's also likely that isn't going to change anytime soon. This is a problem for an 8K TV, its primary purpose being consuming content. Not so for a PC. The 8K resolution gives a sharper display with clearer fonts and more detail. Once you've experienced a true high DPI or dots-per-inch PC display, a standard monitor looks very crude. It's like high refresh in that regard. There's no going back once you've experienced it. 8K also gives you more desktop space.

MAKING CONNECTIONS

Similarly, most modern games will, in theory, run at 8K. So, you could argue the PC is already 8K ready. However, that claim requires a little qualification, which brings us to the first of those technical niggles: display interfaces. The most advanced version of DisplayPort currently available is 1.4. With 8K, DisplayPort 1.4 only supports full 8bpc color per channel and 4:4:4 chroma subsampling at 30Hz. To achieve 60Hz, you either need to kludge it with two connections, use display stream compression, or drop to 4:2:0 subsampling. For 120Hz, you'll need compression and a drop in subsampling.

As for HDMI, you'll need a 2.1 port to run at 60Hz. Currently, there are no video cards with HDMI 2.1 support. That's not a major issue given DisplayPort is, in any case, the more PC-centric interface, but it's worth bearing in mind. Problem number one, then, is that we are years away from a situation where you can have 8K combined with full fidelity color and a refresh rate of 120Hz or more. For the foreseeable future, you're going to have to make a compromise somewhere.

Assuming you're over the interface hurdle, next up is the difficulty driving any 3D application at 8K. In simple terms, 8K creates four times as much load for your graphics card as 4K. Given there are few, if any, video cards that can play literally any game smoothly at 4K with all the bells and whistles maxed out, the idea of playing the most demanding titles at 8K is rather fanciful to say the least.

The thing is, 8K gaming almost certainly will be possible one day. In the meantime, running interpolated at, say, 4K on an 8K monitor looks nearly as good as native 4K (yes, this is something we have experimented with, something we've seen with our own eyes). So, you have the option of enjoying the benefits for font rendering, desktop space, and general clarity and precision while you wait for GPU technology—and, indeed, video content—to catch up.

Of course, 8K doesn't exactly help with production costs and, in turn, monitor prices. What with technologies such as local dimming backlights, support for HDR, wider color gamuts, adaptive synching, and all the rest, PC monitors have been getting awfully complex. By way of example, if you want a PC monitor with 120Hz-plus refresh, 4K, and HDR, you're looking at over $1,000. One day, we'll be able to add 8K to that list. When that will happen isn't clear, but it ain't gonna be cheap, that's for sure.

That said, if you can live with 60Hz refresh, odds are 8K monitors will be pretty affordable—and fairly soon, at that. Observe the impact of 4K TVs on the PC monitor market. 40-inch monitors based on 4K TV panels are available for under $500. Meanwhile, 27-inch 4K monitors with cheap TN panels can be yours for under $300. So, yes, 8K monitors currently cost megabucks; Dell's UP3218K (see boxout, right) is one of the few currently available models, and it still costs nearly $4,000 well over a year after it first appeared. But give it a few years for 8K TVs to gain some traction, and the PC monitors that follow will almost certainly be surprisingly affordable. ⏻

in the lab

Dell UP3218K

High DPI comes to the desktop

8K TODAY, NOT TOMORROW

What's Dell's 8K monitor actually like?

Almost a year ago, Dell's 8K UP3218K landed in the Maximum PC Lab. What was it like? If you're into font rendering, the answer is seriously sexy. With the 8K resolution compressed into 32-inch proportions, the result is Retina-style 275 dpi pixel density. Yum.

Seeing really high res photos, renders, and video in all their glory is another upside. The ability this screen gives image professionals to survey the full detail in multi-megapixel pictures certainly separates it from the 4K masses. Editing 4K video in a small window but at full resolution is a neat trick, too.

The UP3218K requires dual DisplayPort 1.4 connections for 60Hz operation, which is a pain, and it ran painfully hot across the top of its main bezel, which didn't bode well for long-term reliability. You can forget playing games at native resolution for now, and it doesn't support higher refresh rates at lower non-native resolutions either. It's therefore very much an early adopter product. And by Grabthar's Hammer, it's expensive at $3,700. But for clarity and precision of image, there's nothing quite like it on the desktop.

8K is the next big thing in TVs. The PC will almost certainly follow.

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MOVE ON FROM WINDOWS 7

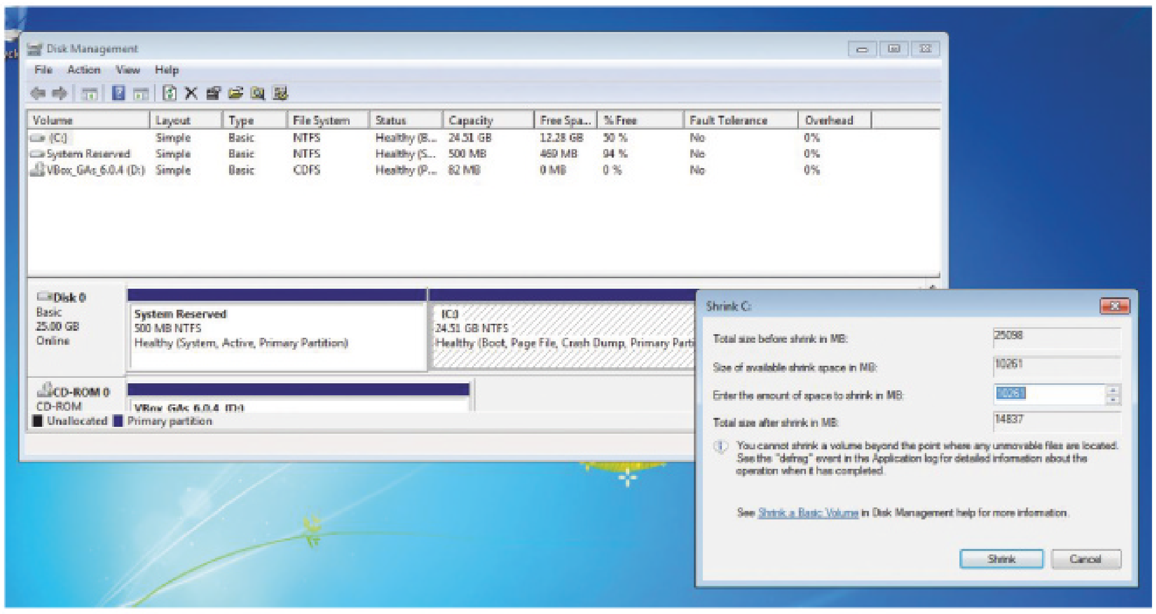
The time has come to upgrade that old operating system.

By Alex Cox

ALTHOUGH THE WORLD might like to argue—statistics show that Windows 10 has only just, in the last few months, beaten Windows 7 in worldwide usage rankings—Microsoft has made its decision. The hammer will come down on Windows 7 in early 2020, and unless you're part of a business willing to pony up a whole load of cash, all support for it will be dropped. That means no updates, no security patches, nothing. It'll be put out to pasture, to live out the rest of its days on a beautiful farm, increasingly infested by worms and open wounds.

In truth, you might not be overly worried about this. No more Windows Updates sounds like bliss to some people. Indeed, Microsoft ceased all major updates for Windows 7 way back in 2015; a reduced tendency to shut down at a moment's notice in order to grind away at your hard drive is, realistically, one of Windows 7's big selling points in this day and age. But you should be worried. While you might prefer Windows 7's more simple, streamlined interface over the ever-changing landscape of Windows 10, it's almost a decade old. Soon it won't only be Microsoft abandoning support—it'll be everyone. Valve, for example, recently ditched Windows XP and Vista support for Steam, and while Windows 7 represents a big chunk of its market, it won't forever.

Whisper it, but moving to Windows 10 makes a huge amount of sense. Microsoft intends, at least right now, for Win 10 to be its last operating system. It won't be abandoned or outdated—rolling feature updates mean major new versions make their way to your desktop twice a year. The longer it stays around, the better it'll become (at least in theory), and even if you're a committed Windows 7 user running older hardware, you'll probably be surprised at how slick and speedy it truly is. The time has come to move on—but even if you're steadfastly staying put, or going elsewhere, there's a lot you need to know.



Volume	Layout	Type	File System	Status	Capacity	Free Spa...	% Free	Fault Tolerance	Overhead
(C:)	Simple	Basic	NTFS	Healthy (B...	24.51 GB	12.28 GB	50 %	No	0%
System Reserved	Simple	Basic	NTFS	Healthy (S...	500 MB	469 MB	94 %	No	0%
VBox_GAs_6.0.4 (D:)	Simple	Basic	CDFS	Healthy (P...	82 MB	0 MB	0 %	No	0%

Disk 0
Basic
25.00 GB
Online

System Reserved
500 MB NTFS
Healthy (System, Active, Primary Partition)

(C:)
24.51 GB NTFS
Healthy (Boot, Page File, Crash Dump, Primary Parti

CD-ROM 0
CD-ROM
VBox_GAs_6.0.4 (D:)

Unallocated
Primary partition

Shrink C:

Total size before shrink in MB: 25098

Size of available shrink space in MB: 10261

Enter the amount of space to shrink in MB: 10261

Total size after shrink in MB: 14837

You cannot shrink a volume beyond the point where any unmovable files are located. See the "defrag" event in the Application log for detailed information about the operation when it has completed.

See Shrink a Basic Volume in Disk Management help for more information.

Create some unallocated space if you want to dual-boot.

WHERE WE ARE

So, what's happening? On January 14, 2020, Windows 7 will reach End of Life status. No new patches or updates will be released, and most likely all help and support for Windows 7 will also disappear. You won't wake up on a cold January morning to find your Win 7 machine blue-screened and dead. More likely, you'll get a notification that support has ended (perhaps with a final plea to upgrade to Windows 10), and be allowed to go on with your day. That's the good news. The bad news is that, as of January 15, Windows 7 becomes a huge target for hackers. Any vulnerabilities left unfixed will stay unfixed. Viruses and malware targeting these holes will undoubtedly be rife, particularly given Win 7's huge user base, to date far larger than the 29 percent held by Windows XP when it hit End of Life in April 2014.

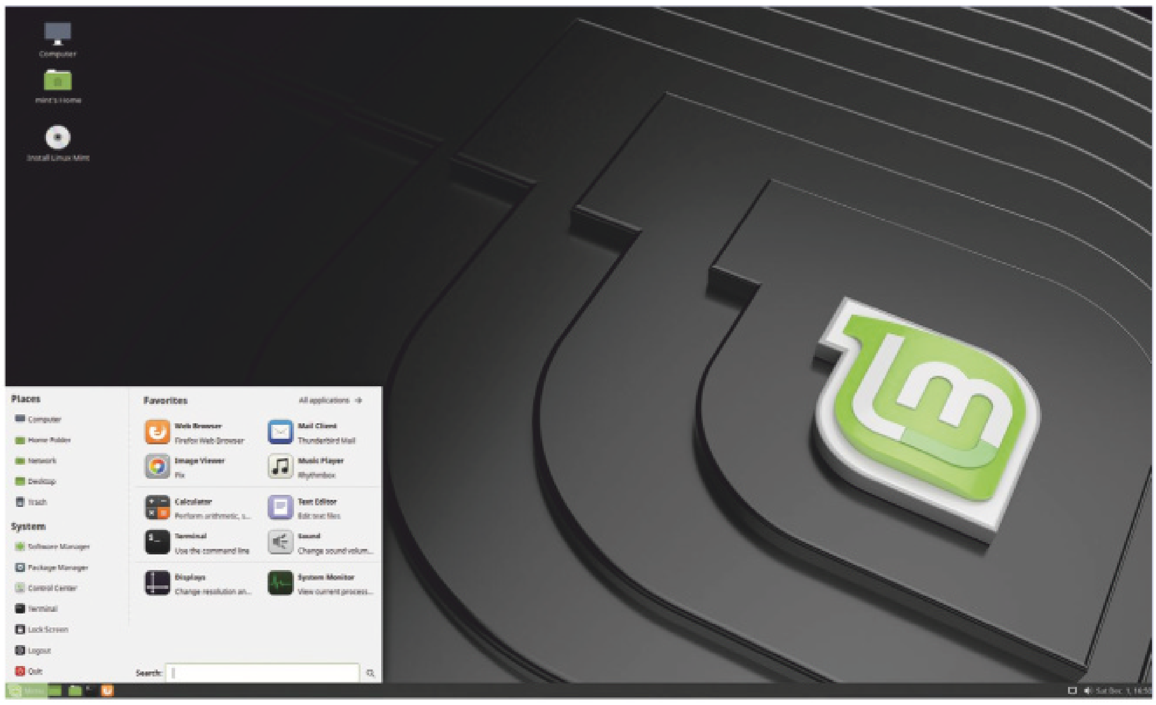
You have a number of choices, which we'll break down. You can grit your teeth (or perhaps open your wallet) and continue to use Windows 7. You can make the leap to Windows 10, which is surprisingly friendly to older hardware. You can, if you're really lagging behind, grab some new hardware. Or, if you're feeling cavalier, you could use this as your incentive to move to Linux. We're not telling you what choice to make, but it pays to know what you're getting into before you nail it down.

STICKING WITH 7

As we said, Windows 7 isn't going to self-destruct when it reaches End of Life. And, weirdly, despite its imminent death, Microsoft isn't going to actually stop supporting it, at least if you're running a business-grade edition. Extended security updates will be available for at least the three years that follow End of Life, on a sliding price scale. Windows 7 Enterprise Edition users will be charged $25 per machine in year one, $50 in year two, and a cool $100 for the year ending January 2023. Windows 7 Pro edition prices are twice that, meaning you'll end up spending as much as a full-price Windows 10 license by the end of the second year. That's quite the incentive.

Realistically, it's possible you don't absolutely need any future security updates. If you're running a fairly static machine—a Windows 7 PC acting as a server, for instance, or a single-purpose media box that's not necessarily going to rely on future software support—it's entirely possible that you won't be installing anything new or performing too many online actions. In these cases, if you're incredibly careful, cagey, and can handle the anxiety, it should be feasible to carry on as you were, as long as you keep in mind that malware that exploits network vulnerabilities may still snake its way into that box from another source.

We certainly foresee many businesses sticking with 7 and not paying the Microsoft tax; we've witnessed enterprising "ain't broke" individuals running DOS-based interfaces, and even, once, a Commodore 64, so it's not unheard of. But again, it's not sensible, and if you do decide to take this tack, make sure everything you care about is backed up safely away from that Windows 7 box. There will also be people who don't want to give up a well-honed and tuned Windows 7 install. In this case, it's entirely possible to dual-boot Windows 10 and Windows 7, though that's basically the epitome of operating system pettiness. On Windows 7, shrink your main drive using the Disk Management tool (or hook up a second internal drive, if you're able), then when installing Windows 10, choose a custom install, and drop it in that now-unallocated space.



Linux Mint is easy to get started with, and close to that cozy Windows layout.

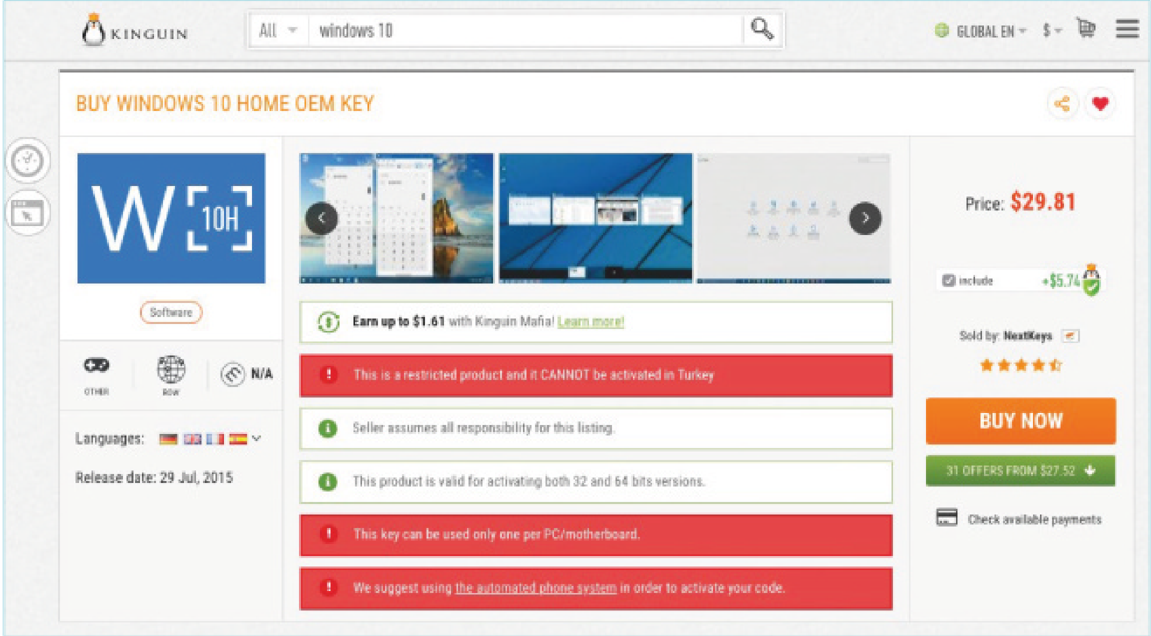
ALL THE WAY TO 10

At this point, you have missed the boat on (officially) moving up to Windows 10 cost-free. Microsoft's GWX tool, the over-forward pop-up that encouraged Windows 7 users to upgrade for zero bucks, disappeared on schedule in mid-2016. That makes sense; when Windows 10 first launched, Microsoft was eager to fudge the numbers, offering to upgrade your Windows 7 (or Windows 8, or 8.1) license to Windows 10 for free. After that, time to sell some licenses—Windows 10 Home will set you back $120, while the Pro version costs $200. But that's not necessarily the end of the story. It's possible to get a much cheaper key (see "Bag a Bargain" opposite), and you may not even need to pay at all.

You can, first of all, install and run Windows 10 without activating it. Heading to www.microsoft.com/en-us/software-download/windows10ISO usually brings up Microsoft's media creation tool (annoyingly), although if you visit that site from another OS, such as Linux, you can download the ISO directly. To fix this, open the link in Edge or Internet Explorer, hit F12, enter the "Emulation" tab, and change your user agent string to pretend you're visiting from an iPad. You can now grab the ISO directly. Write it to a USB stick with Rufus (https://rufus.ie), head through the install procedure, and when asked to activate, select "I don't have a product key." If you're planning to upgrade to the activated version later—you can purchase a key through the Microsoft Store—make sure you opt to install the Home edition, rather than the more expensive Pro, unless you're sure you need the extra features of the latter. If you run unactivated, you have to put up with a watermark on your desktop, a limited selection of personalization options, and no support—but you can do it. It's not going to stop working, and even unactivated installations are eligible for Microsoft's standard update program.

If you want to go straight, there's also the slightly unofficial but apparently rather effective route of installing Windows 10 using your existing Windows 7 key. If it's legitimate, it seems an old key generally works just fine, despite Microsoft outwardly dropping its upgrade scheme, although we're not offering any concrete assurance here, as certain keys may not work at all. Check your hardware for a certificate of authenticity sticker, or run Nirsoft's ProduKey (www.nirsoft.net) to dredge up the key from your existing installation if you don't already know it.

Bear in mind that using an older key on a new install invalidates it on the old one, so dual-booting isn't an option in this case. If you run into problems, it may well lock out the key on both ends, meaning you'll need to make an uncomfortable call to Microsoft Support to sort it out—do this before Windows 7 is trashed, in case you need to step back, and again make sure that everything you care about is archived away from either machine before trying it.



BUY WINDOWS 10 HOME OEM KEY

Languages:

Release date: 29 Jul, 2015

Earn up to $1.61 with Kinguin Mafia! Learn more!

This is a restricted product and it CANNOT be activated in Turkey

Seller assumes all responsibility for this listing.

This product is valid for activating both 32 and 64 bits versions.

This key can be used only one per PC/motherboard.

We suggest using the automated phone system in order to activate your code.

Price: $29.81

Sold by: NextKeys

BAG A BARGAIN

Psst, over here—we hear you're looking for a sweet deal. Take a look inside the stained trenchcoat of a third-party key reseller, and you might be surprised; a Windows 10 key, generally overstock sold on from a wholesale bulk buy, or sometimes a key bought with a cheaper foreign currency and passed down the line, could cost you as little as $30. What a bargain, right? While we're not trying to discourage you from heading to a site like www.kinguin.net, www.pcdestination.com, or even a big retailer like Amazon or Newegg in search of a cheap key, there are a few things you need to beware of.

This is risky. We're not vouching for any of these sites because there's a small chance that the key you buy could be illegitimate or double-sold. It's wise to opt to shop with a business that might offer a refund if all goes wrong, and that doesn't, in this case, include Amazon or Newegg, whose key sales are final—if there's a problem on these sites, you need to take it up with the individual seller. Some charge a premium for refund protection (Software Pug asks for an extra $20, which also includes installation support).

There's no specific legal impediment to buying a key in this way. Retailers claim it isn't even a gray market—more the equivalent of picking up a dusty key from a Costco pallet rather than selecting an artisanal key from the shelves of Saks Fifth Avenue. You'll certainly have the best recourse should you buy from Microsoft directly, but if you want to take an unactivated Windows 10 install legit, you could do worse than dropping a few bucks on a third-party key.

Want to play *Overwatch?* With Wine, it's possible to run the Windows version on Linux.

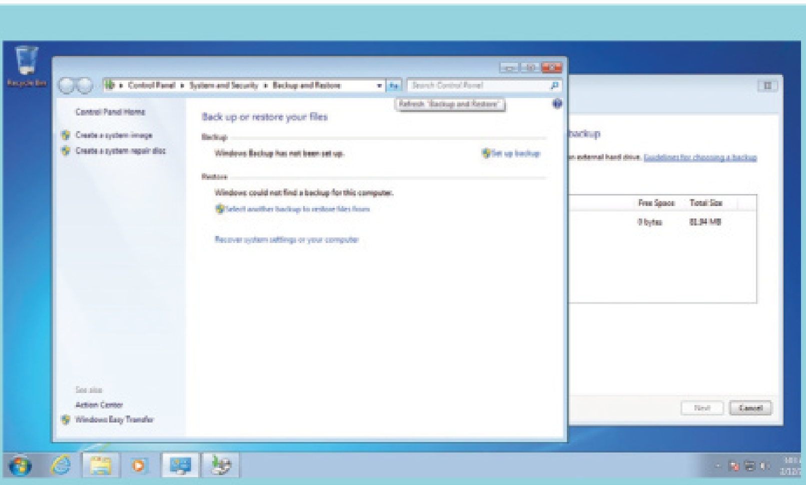
UPGRADE TIME

Perhaps you've been clinging on to Windows 7 because you feel your current hardware can't keep up. That's probably not true; we've run Windows 10 on machines as lowly as old netbooks, and it's performed reasonably well on everything we've tried. In fact, the listed minimum requirements for both Windows 7 and Windows 10 are

BACK IT UP

It doesn't matter how many times you do it, or just how reliable the process is, upgrading an existing install to a new OS version is scary and a little risky. If it goes bad, you're screwed—particularly if you've not taken the proper steps to keep your precious data safe. We could go on and on about the backup tips you've already heard—three copies in at least two places, one of which is off-site—but we'll presume you're doing that already. The critical backup here is a fail-safe—a cache of your files that's ready to go on the off chance that something goes wrong. It's essential whether you're upgrading, switching, or doggedly sticking to a now-vulnerable Windows 7.

You could create a full system image, using Windows 7's built-in backup tools or something like Macrium Reflect (www.macrium.com), to mirror your main hard drive on some external medium. This is perfect if you feel you might want to return to Windows 7 in the future, because it takes everything, but it's useless if you're later looking to access your files directly, as they'll be compressed and packaged within that image. Windows 7's main backup tool (type "backup" in the search box) is a better option, as it copies the files themselves—once they're on your external drive, you can restore them to your new PC using Windows 10's File History tool, and continue using it to keep rolling backups of your main files seamlessly. Poking around in Explorer at the clumsily renamed items in a File History backup might lead you to imagine that these files are non-standard, but they're exactly as they were before, bar the filenames, so they can also be opened in a Linux install without a problem.


Control Panel ▸ System and Security ▸ Backup and Restore
Search Control Panel
Refresh "Backup and Restore"
Control Panel Home
Create a system image
Create a system repair disc
Set up backup
Select another backup to restore files from
Recover system settings or your computer
See also
Action Center
Windows Easy Transfer
Free Space
Total Size
Next
Cancel

Back up or restore your files

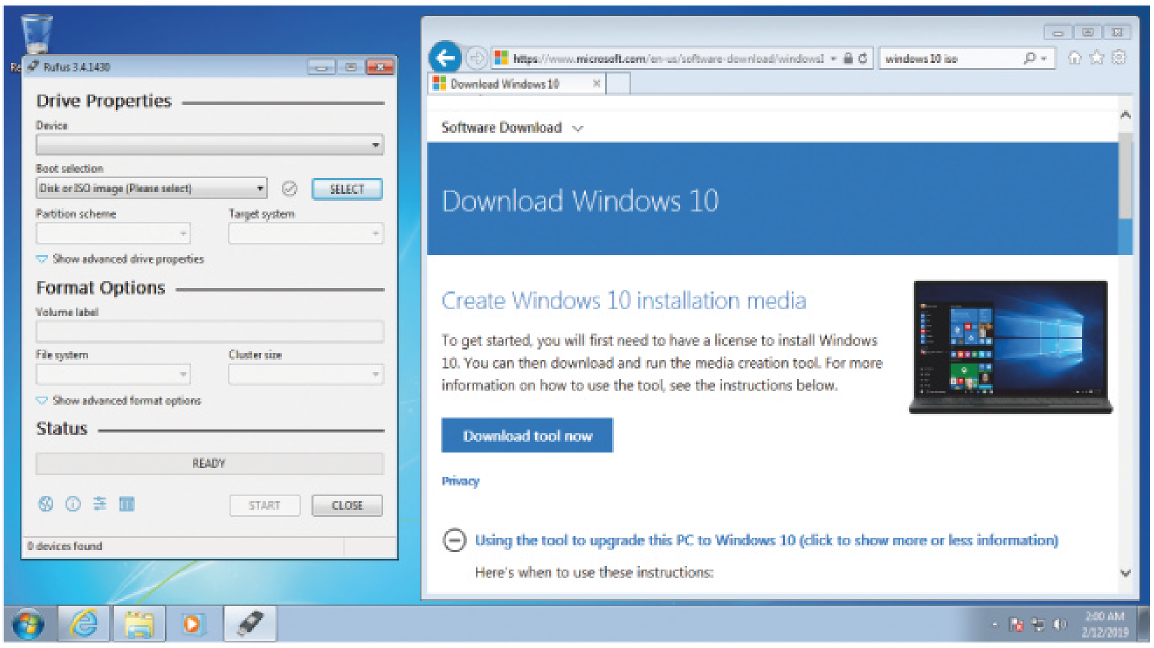
Backup

Windows Backup has not been set up.

Restore

Windows could not find a backup for this computer.

You don't need external tools to copy your Windows 7 files.


Rufus 3.4.1430
Drive Properties
Device
Boot selection
Disk or ISO image (Please select)
SELECT
Partition scheme
Target system
Show advanced drive properties
Format Options
Volume label
File system
Cluster size
Show advanced format options
Status
READY
START
CLOSE
0 devices found
Software Download
Download tool now
Privacy
2:00 AM
2/12/2019

https://www.microsoft.com/en-us/software-download/windows1

windows 10 iso

Download Windows 10

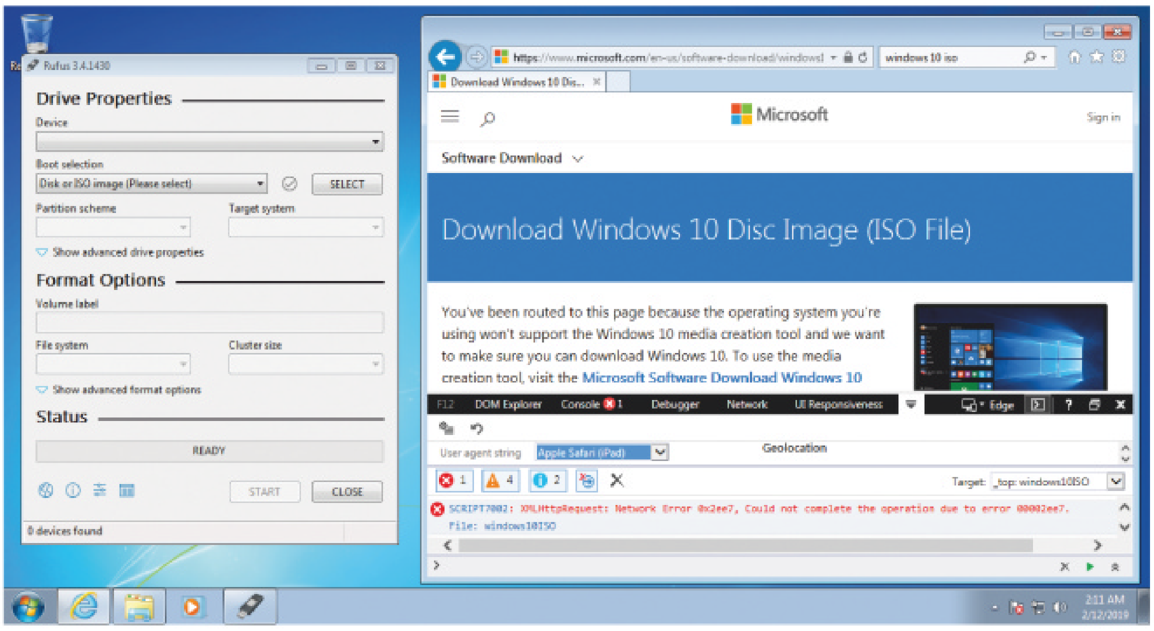
Create Windows 10 installation media

To get started, you will first need to have a license to install Windows 10. You can then download and run the media creation tool. For more information on how to use the tool, see the instructions below.

Using the tool to upgrade this PC to Windows 10 (click to show more or less information)

Here's when to use these instructions:

Want to download a plain Windows 10 ISO? The media tool wants an existing license...


Rufus 3.4.1430
Drive Properties
Device
Boot selection
Disk or ISO image (Please select)
SELECT
Partition scheme
Target system
Show advanced drive properties
Format Options
Volume label
File system
Cluster size
Show advanced format options
Status
READY
START
CLOSE
0 devices found
Download Windows 10 Dis...
Microsoft
Sign in
Software Download
F12
DOM Explorer
Console
Debugger
Network
UI Responsiveness
Edge
Geolocation
2:11 AM
2/12/2019

https://www.microsoft.com/en-us/software-download/windows1

windows 10 iso

Download Windows 10 Disc Image (ISO File)

You've been routed to this page because the operating system you're using won't support the Windows 10 media creation tool and we want to make sure you can download Windows 10. To use the media creation tool, visit the Microsoft Software Download Windows 10

User agent string: Apple Safari (iPad)

Target: _top: windows10ISO

```
SCRIPT7002: XMLHttpRequest: Network Error 0x2ee7, Could not complete the operation due to error 00002ee7.
File: windows10ISO
```

...but you can fake your user agent to download the ISO without it.

identical—a 1GHz processor, 1–2GB RAM, 16–20GB hard disk space, and a DirectX 9 compatible graphics card. What runs on one should run on another. Credit to Microsoft for streamlining its latest OS; if you previously gave Windows 8 or 8.1 a go and rolled back in disgust, you won't find the same performance hang-ups with 10, although those minimums are just that. We recommend hardier hardware—at least a 2GHz dual-core CPU, at least 4GB RAM, and far more than the stated hard drive requirements if you're partial to keeping any files at all on a PC that doesn't grind to a halt at a moment's notice.

That said, you may be looking at Windows 7's current place in front of the firing squad as an opportunity to pick up some new hardware. We'll leave recommendations for specific upgrades to other features, particularly since just about anything you buy today will be up to the task, but it's worth considering that Microsoft's authentication tools look at the makeup of your system components to determine the validity of your key—if you're building your own PC, or making big changes to an existing one, it helps to have your Windows key tied to your Microsoft account, so you can use the Activation troubleshooter to iron out any problems.

On Windows 10, head to "Settings → Update & Security → Activation" to check if you're linked—you'll see "Windows is activated with a digital license linked to your Microsoft account" if so. If it's not working, first head to "Settings → Accounts → Your info," and confirm you're logged in to Win 10 as an administrator using your Microsoft account, then head back to the Activation panel. Fire off the Troubleshooter, let it know you've made hardware changes, and enter your account details. Select the package of hardware you're using, and Windows reassigns itself to your current device.

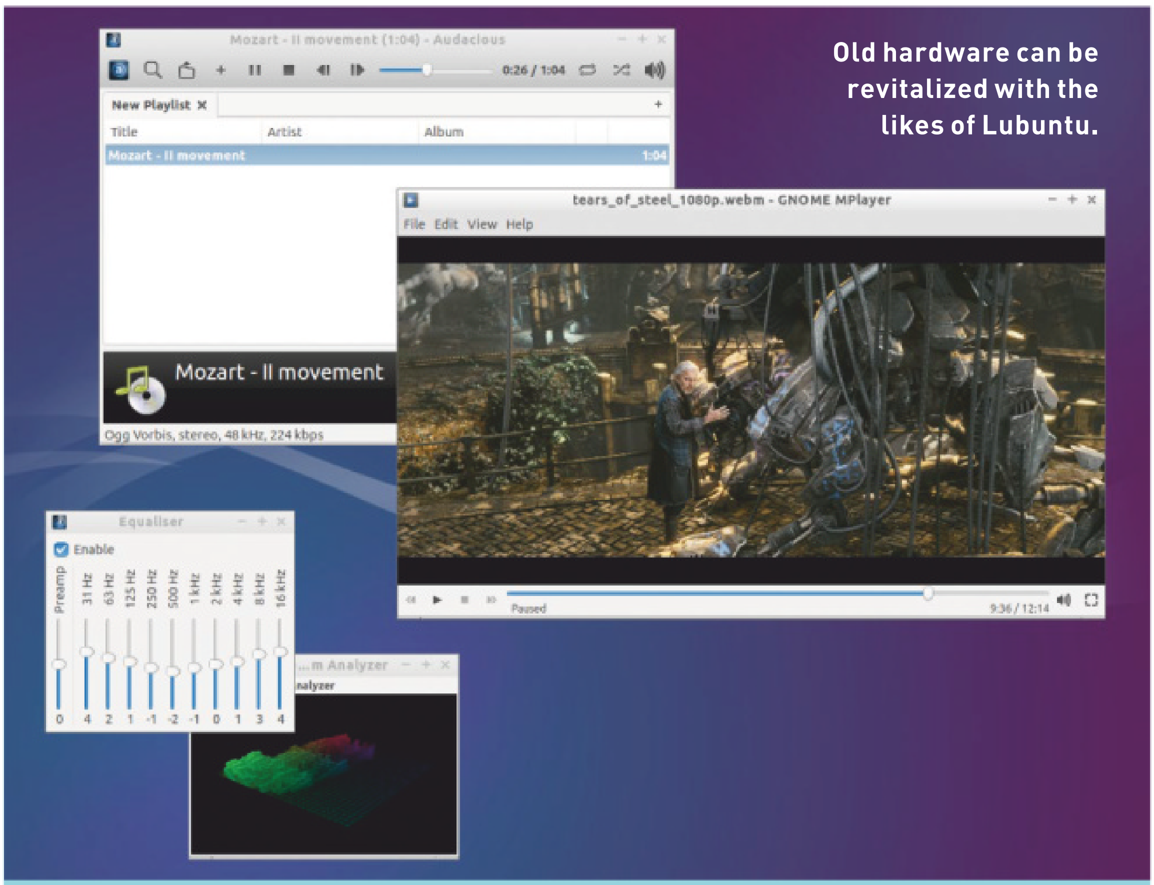
PENGUIN POWER

This all seems like a lot of hassle, right? If you're already chipping away at the Windows coalface for hours on end, you might as well make fighting with your OS a full-time job, and move the whole shebang to Linux. Facetious setup aside, Linux does have a bunch of benefits. For one, it's free—no expensive or potentially shifty keys to buy—and you're all but guaranteed to never reach any sort of End of Life state, as long as you're not running some obscure distro with shaky support behind it. That means, as long as you don't fight off security updates, your OS will be kept secure by the enthusiastic teams of developers who maintain Linux distros, and since (as a platform) it's far less common in the wild than Windows, not to mention more difficult to attack, driving a Linux box is likely a safer way to run a PC.

Linux can be great for lower-end systems that won't be able to keep up with the pressures of running Win 10. If you're upgrading (far too late) from Win XP or Vista, a low-end distribution is a great choice to restore at least some functionality to dusty old hardware—see "Low-end Linux" (right) to find out more. If you have sprightlier hardware, there's a host of mature and highly capable distros that can ease you into Linux nicely; avoid the likes of Arch Linux (apparently deliberately obtuse) or Gentoo Linux (so complicated to build and install that you'll have grown a Linux guru beard before even hitting desktop), and lean more toward the likes of Ubuntu Linux or Linux Mint, two Debian-based distros geared toward simplified desktop use. The latter, in particular, has a default interface that'll be familiar to Windows veterans.

There are some obvious downsides to going Linux. Windows apps aren't natively compatible, so you'll lose your current catalog. There are generally free alternatives available to most Windows applications that do the job just as well—LibreOffice in place of Microsoft Office, for example—although you may find the odd bit of functionality missing. If you really must use Windows apps, the majority of them can be wrapped in a compatibility layer using Wine (www.winehq.com), which should make them run as if you were firing them up natively on Windows.

Linux is also a rather poor choice if you're using your PC for gaming. Despite Valve's best efforts with SteamOS and the like, it really hasn't taken off as a Steam-friendly platform—there's a decent catalog of games, but Windows is (and will remain) the PC platform of choice for the latest titles and the latest GPU driver updates, meaning it'll almost always be more stable and more up to date. Wine is, again, an option, though it isn't hugely helpful in this regard; although it does support DirectX, the extra compatibility layer means you'll take a performance hit. Games such as *Hearthstone*, *League of Legends*, and even *Overwatch* run fine as long as you install the latest Wine staging patches, which detail exactly the kind of setup they're looking for, but don't expect your entire collection to play the same. ⏻



Old hardware can be revitalized with the likes of Lubuntu.

LOW-END LINUX

Even the crustiest PC can be scraped back into shape with the right OS. You don't need to stray far from the trusty Linux standards, either; Lubuntu is a lightweight flavor of Ubuntu that switches out its usual Gnome 3 window manager for the lightweight LXDE desktop, and drops some of the more system-intensive apps in favor of lighter alternatives. It might be dialed down, but that doesn't mean you can't dial it up again, as Lubuntu is compatible with standard Ubuntu software repositories. If there's something there you want, you can get it—although if you're running on the lowest possible specs (claimed to be just 512MB RAM), don't expect absolutely everything to work.

There are other minimal editions of Ubuntu (LXLE, in fact, is a respin of Lubuntu, targeted at lower-end computers), and many other reduced distros to try. You could go crazy and install the 16MB TinyCore, though that's not really a Windows replacement as much as it is a demonstration of minimization; you could try Damn Small Linux, a 50MB distro that can run on a 486, but as it was last updated in 2008, you'll need to use the MyDSL Extension Tool if you want to bring it up to this decade's standards.

Probably the biggest name in cut-down Linux is Puppy Linux, having been serving the market for 12 years. Try, in particular, the XenialPup flavor, which is compatible with Ubuntu 16.04. It's packed with useful apps, can also install Ubuntu apps, and its own QuickPet utility helps you get your paws on a much wider selection of tools if its default collection—which includes odd ducks, such as the Homebank personal finance manager—isn't quite what you were looking for.

TECH PORN

Brilliance 499P
PH

Philips Brilliance 499P9H Ultra-Wide 49-inch Monitor

STOP THAT, IT'S SILLY. So goes the immortal Monty Python meme, and we're beginning to think it applies to the PC monitor market, especially when it comes to ultrawide screens. It started in 2012, with a 29-inch LG monitor with a cinematic 21:9 aspect ratio. That was followed by a gaggle of 34-inch models sporting the same basic proportions. Then 38-inch alternatives appeared, by which point 21:9 almost looked normal.

It was the announcement of the 49-inch Samsung C49HG90 where the comedy arguably emerged. 49-inch itself raises ergonomic questions in a desktop context. But when those 49 inches are arranged in a 32:9 aspect ratio, the conundrum sails right past ergonomics, and flirts with epistemology. What on earth is going on? The Samsung is particularly challenging with its mere 1,080 vertical pixels. Enter, therefore, the hot new Philips Brilliance 499P9H. Like the Samsung, it's 49 inches and 32:9 ratio. But it ups the vertical pixel count to 1,440, and with that 5,120 horizontal pixels. So, the desktop space is arguably more useful. But still. That aspect ratio.

What's intriguing is that the first 21:9 panels took a lot of getting used to, but are now widely popular, pun intended. So the question is whether it's merely the novelty of 32:9 that's hard to process, and that just like 21:9, it will normalize into broad appeal, or whether it's a ratio too far. Time will tell. –**JEREMY LAIRD**

1 WONDERFUL WIDESCREEN

Actually a 48.8-inch panel, Philips has gone for VA tech, which enables excellent 3,000:1 static contrast, seriously punchy colors, and decent viewing angles. It does have DisplayHDR 400 certification, but that doesn't make for true HDR visuals, thanks to a lack of local dimming and a middling 450cd/m^2 peak brightness.

2 GET CONNECTED

Connectivity is a strong point for the 499P9H. That starts with a USB Type-C interface for slick single-cable connections to a laptop, though bear in mind that the 5120x1440 pixel resolution is pretty demanding. Philips has also included a KVM switch, and supports two PC outputs on the display in parallel.

3 HMMMM, UPGRADES

Other highlights include a pop-up webcam that supports Windows Hello sign-in, then slips back into the chassis. Nice. Likewise, while the refresh tops out at 60Hz, there is adaptive sync to smooth out gaming performance. There's also an Ethernet port that can provide networking through the USB-C interface. Clever.

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DISPLAY UNTIL 04/11/19

```
#!/usr/bin/env python3
# Python intro 2018

def main():
    print('Hello world')

def loop():
    for j in range(5):
        print(j)

if __name__ == '__main__':
    main()
```

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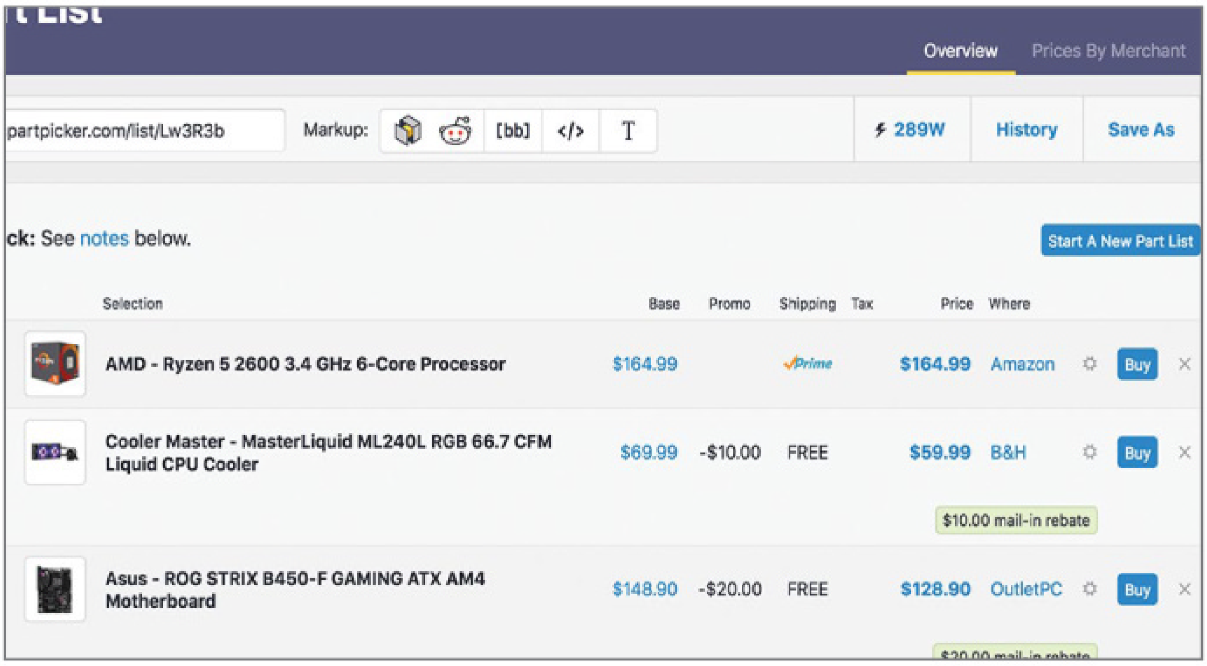
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



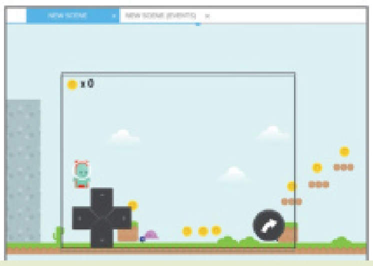
ck: See notes below.

Selection	Base	Promo	Shipping	Tax	Price	Where
AMD - Ryzen 5 2600 3.4 GHz 6-Core Processor	$164.99		✓Prime		$164.99	Amazon
Cooler Master - MasterLiquid ML240L RGB 66.7 CFM Liquid CPU Cooler	$69.99	-$10.00	FREE		$59.99 $10.00 mail-in rebate	B&H
Asus - ROG STRIX B450-F GAMING ATX AM4 Motherboard	$148.90	-$20.00	FREE		$128.90	OutletPC

HOW BIG A PSU DO YOU NEED?

Whenever it comes to speccing out a rig, the first thing we are asked is: "What size power supply do I need?" In our honest opinion, the best thing to do is head to www.pcpartpicker.com, create a new build, then in the top-right corner, it'll give you a rough estimate of what your power usage will be at peak load. Aim for a power supply capable of 25 percent more than that (or even beyond if you want a quiet PSU), and you'll be golden.

MAKE – USE – CREATE



56
Quickly build 2D games with GDevelop

64
Create moving smoky hair with video in Photoshop

68
An RTX 2080 system to star in a commercial video

ZAK STOREY
CONTRIBUTING EDITOR

DREAM MACHINE 2019

It's finally happening folks: Dream Machine 2019 is coming. Next issue, in fact. It was one hell of a tough decision for us to hold off on Dream Machine 2018, and we know a lot of folk were disappointed by that choice. Even though I championed the hiatus, not completing the annual feat didn't sit easy with me. After all, it's part of *Maximum PC's* history, and Dream Machine holds a special place in the magazine's pages, so skipping it for a year was difficult.

This time, though, with processors, graphics cards, and memory galore, crafting this year's creation is an easy choice to make. We're teaming up with a whole ton of partners to bring this mad monstrosity to life. Corsair, Asus, Samsung, EKWB, AMD, Intel, and Nvidia are all joining us on the project. Yup, the three biggest brands in the tech industry, names that ruffle the feathers of many a fanboy, are working side by side to create something exceptional.

So, hold on tight folks, because by the time the month is out, this technology journalist is going to be all out of sanity once again, as he fights to tame a twin-system, liquid-cooled, price-tag-free beast into submission.

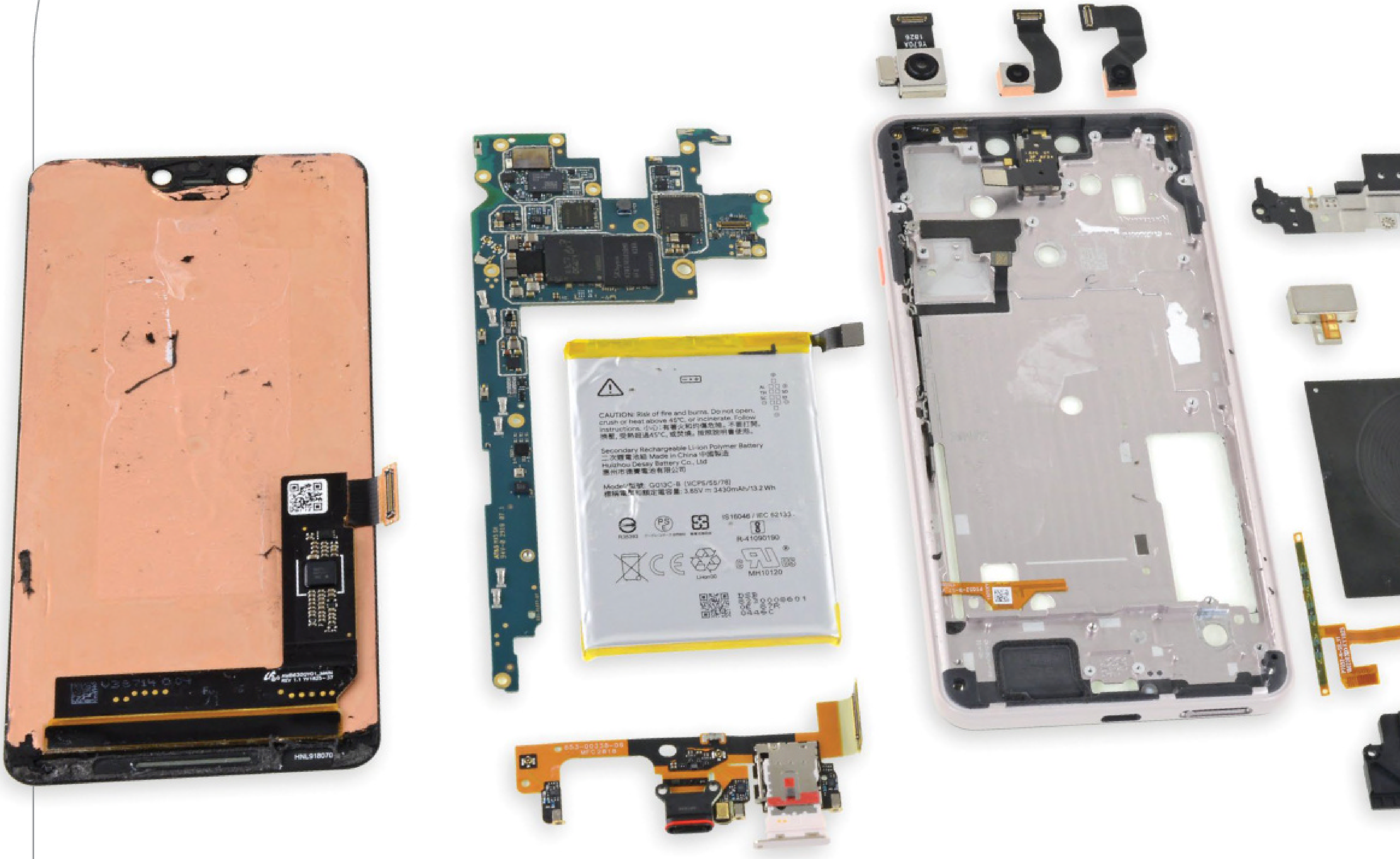
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

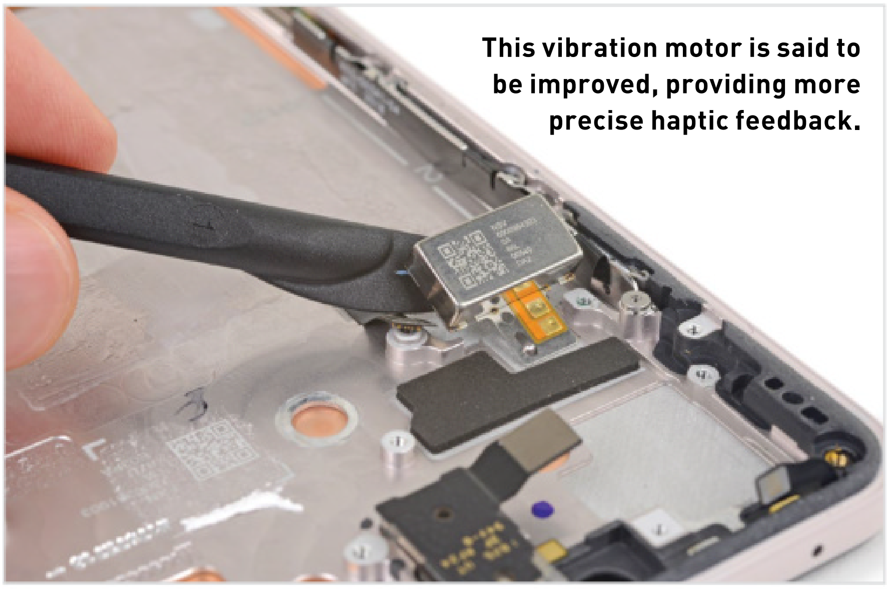
AUTOPSY

THIS MONTH WE DISSECT...

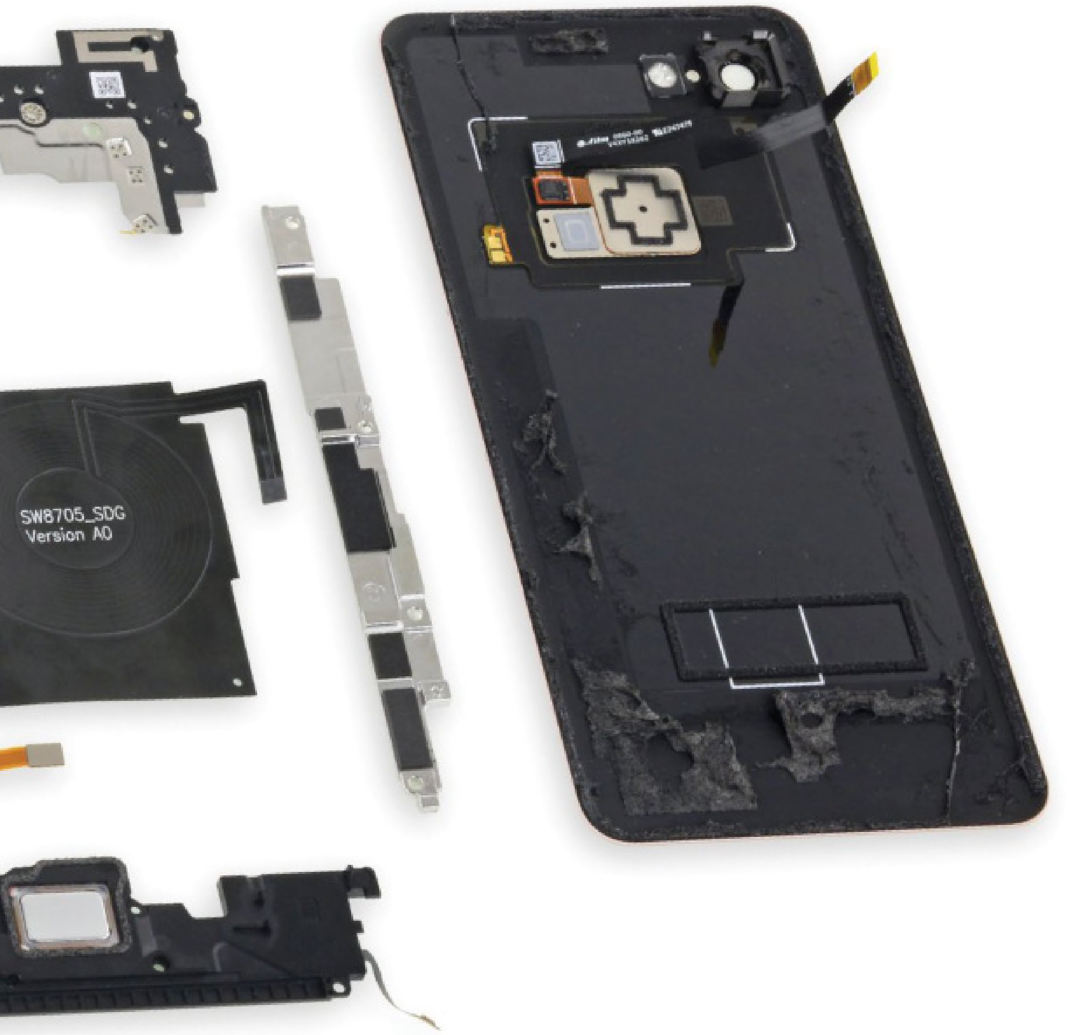
Google Pixel 3 XL



There's plenty of adhesive inside, but some is easier to work with than the rest.



This vibration motor is said to be improved, providing more precise haptic feedback.



BACKGROUND

The Google Pixel 3 XL is all dressed up in the latest flagship phone uniform: glass on the back and a notch on the front. But we're headed past the shiny new facade, for a closer look at the insides.

MAJOR TECH SPECS

- 6.3-inch OLED display with QHD+ 1440×2960 resolution (523 ppi) and Gorilla Glass 5
- Octa-core 64-bit Qualcomm Snapdragon 845 processor (2.5GHz + 1.6GHz) with 4GB LPDDR4x RAM
- 12MP f/1.8 OIS main camera with dual-pixel phase detection autofocus; dual 8.1MP selfie cameras
- 64GB or 128GB built-in storage
- Qi wireless charging
- IP68 water resistance
- Android 9.0 Pie

KEY FINDINGS

- We need to bring out the big (heat) guns to open the display. It looks like the Pixel 3 XL still uses foam adhesive, but it's far more tenacious than the repair-friendly stuff we saw last year. We grab the iSclack, expecting to separate the display assembly, but the rear cover yields first.
- Thankfully, the fingerprint sensor cable is long enough to avoid being torn by over-zealous openers. Inside is pretty much as expected: a new wireless charging pad, a battery, a board, a couple cameras, and a fingerprint sensor on the rear cover. Less expected are metal covers over the mobo, and a SIM tray hidden beneath the speaker assembly.
- The tough adhesive trend continues, holding the wireless charging coil to the Pixel's powerhouse, but the battery is secured with relatively repair-friendly stretch-release adhesive. We resort to flossing out the battery, but cut a fragile hidden ribbon cable by accident. Forewarned is forearmed—a repair manual would have helped here....
- Above the crater where the battery once lay, we extract an antenna shielding the motherboard. On the south end of the phone, we battle more adhesive to release what seems like another shield, but is actually the speaker housing, which we split in half trying to access the components below. The speaker chamber is sealed with waterproofing adhesive, and that seal has to be broken to access any of the commonly serviced ports on the daughterboard.
- With its shields down, we finally get a look at the newest Pixel's motherboard. As the board comes out, we can't help but notice generous helpings of thermal paste on its underside, to transfer heat from the hardest working chips to the metal frame. The daughterboard comes out without fuss, taking the USB-C port, SIM tray, and some antenna hardware with it. The vibration motor is more reluctant to leave home, but our Halberd Spudger is very persuasive.
- Repairability score: 4 out of 10 (10 is easiest to repair). The only screws are standard T3 Torx ones. Repair-friendly stretch-release adhesive secures the battery. O-rings and adhesives for waterproofing complicate repairs, but make difficult liquid damage repairs less likely. Display repairs are trickier than on previous models, requiring complete disassembly of the phone. To service any component, you must painstakingly unglue the rear panel. Front and back glass means increased vulnerability to drop damage.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products.
To learn more, visit www.ifixit.com.

Quickly Build 2D Games in GDevelop

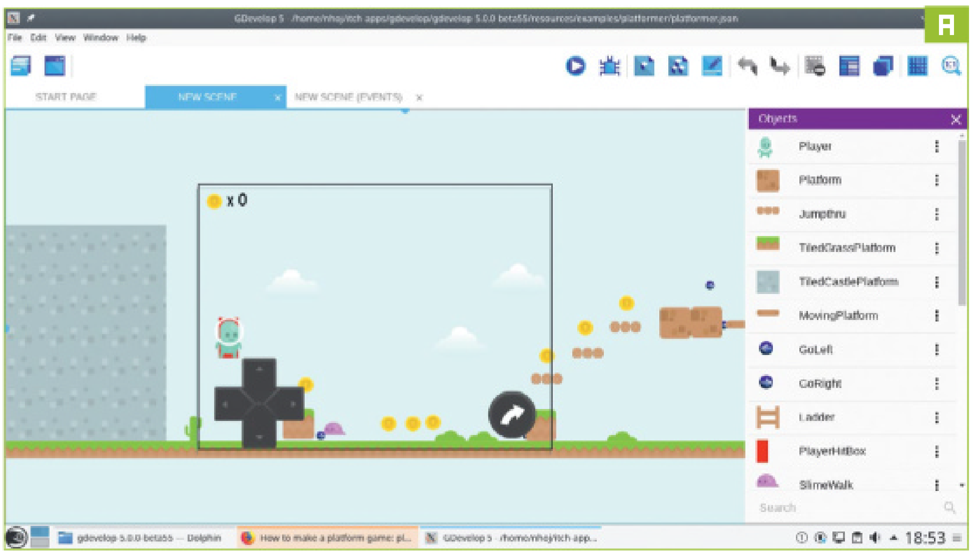
YOU'LL NEED THIS

GDEVELOP
Grab the Windows version or the Linux tarball from https://gdevelop-app.com.

GDEVELOP'S WELCOME SCREEN BOASTS THAT THIS 2D GAME MAKER is "an easy-to-use creator with no programming language to learn." Being Java-based, it runs on Linux, Windows, and MacOS, or you can try it online. Publishing is even better. The license states you can publish, sell, or do anything you like with your games. And you can export to Linux, Windows, Mac, Android, HTML5, and even Facebook Messenger (full iOS support is coming soon). But what about that claim it has "no programming language to learn"? Let's have a closer look.

If you want to run it on Linux, then installation can be a bit of a pain. It probably won't be in your distro repositories, so you need to grab the tarball from https://gdevelop-app.com. It doesn't need compiling, though, and the only dependency it specifies is libgconf-2-4. Download the tarball, extract it, and you should be able to run the executable in the main folder just by clicking it, or by opening a terminal in the folder and entering `$ ./gdevelop`.

If that all sounds tricky, you might consider installing it using Itch, which has a version ready to go. Plus, it comes recommended by the developers, and http://itch.io has a load of Linux games (some of which are made in GDevelop). The most interesting way to explore GDevelop is to open some tutorials and mess around, so let's start there. –**JOHN KNIGHT**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File Edit View Window Help
START PAGE
NEW SCENE
NEW SCENE (EVENTS)
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Objects
Player
Platform
Jumpthru
TiledGrassPlatform
TiledCastlePlatform
MovingPlatform
GoLeft
GoRight
Ladder
PlayerHitBox
SlimeWalk
Search
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How to make a platform game: pl...
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18:53

1 GO EXPLORING

GDevelop [**Image A**] opens to a welcome screen, with the choice to open a project, create a new project, or search the documentation. Choose "Open Project," and if you look in your installation directory, you'll have game tutorials and templates installed, which from GDevelop's main folder should be under "resources/examples" [**Image B**].

» The screen is broken into three tabs: "Start Page," "Scene," and "Scene (Events)." When you open or start a project, GDevelop opens the "Scene" tab, so let's begin there.

» On the left is "Properties," a fold-out panel that displays the properties of any object you click within a scene. In the center is the scene itself, and you can zoom in and out with your mouse wheel. On the right is the "Objects" panel, where you create your game objects, then drag them on to the scene in the middle.

» If you open the "New Scene (Events)" tab, you'll see the programmed events that determine how your game will work. This is the hardest part of GDevelop, but we'll have a taste of this later for a basic demo.

» Lastly, there is the main toolbar on the top-right. These buttons change when you swap between the "New Scene" and "New Scene (Events)" tabs, but one button that stays the same is the "Play" button on the left, which enables you to test the game.

2 MAKING A MESS

You can now take a template and start playing around. A good place to start is the game objects themselves. In the "Objects" panel, right-click an item and choose "Edit Object" The new window is separated into two tabs: "Properties" and "Behaviors." Normally the window is opened in the "Properties" tab, but let's get the "Behaviors" tab out of the way first.

» In the "Behaviors" tab, you can add behaviors for simple things, such as deleting an object that has left the screen, or something more complex, such as altering an object's physics. Just click the "Add" button to introduce a behavior, and press the "Rubbish" icon to delete it again. Scroll down, though, because while some behaviors don't have any options to choose from, others have plenty of options to tweak.

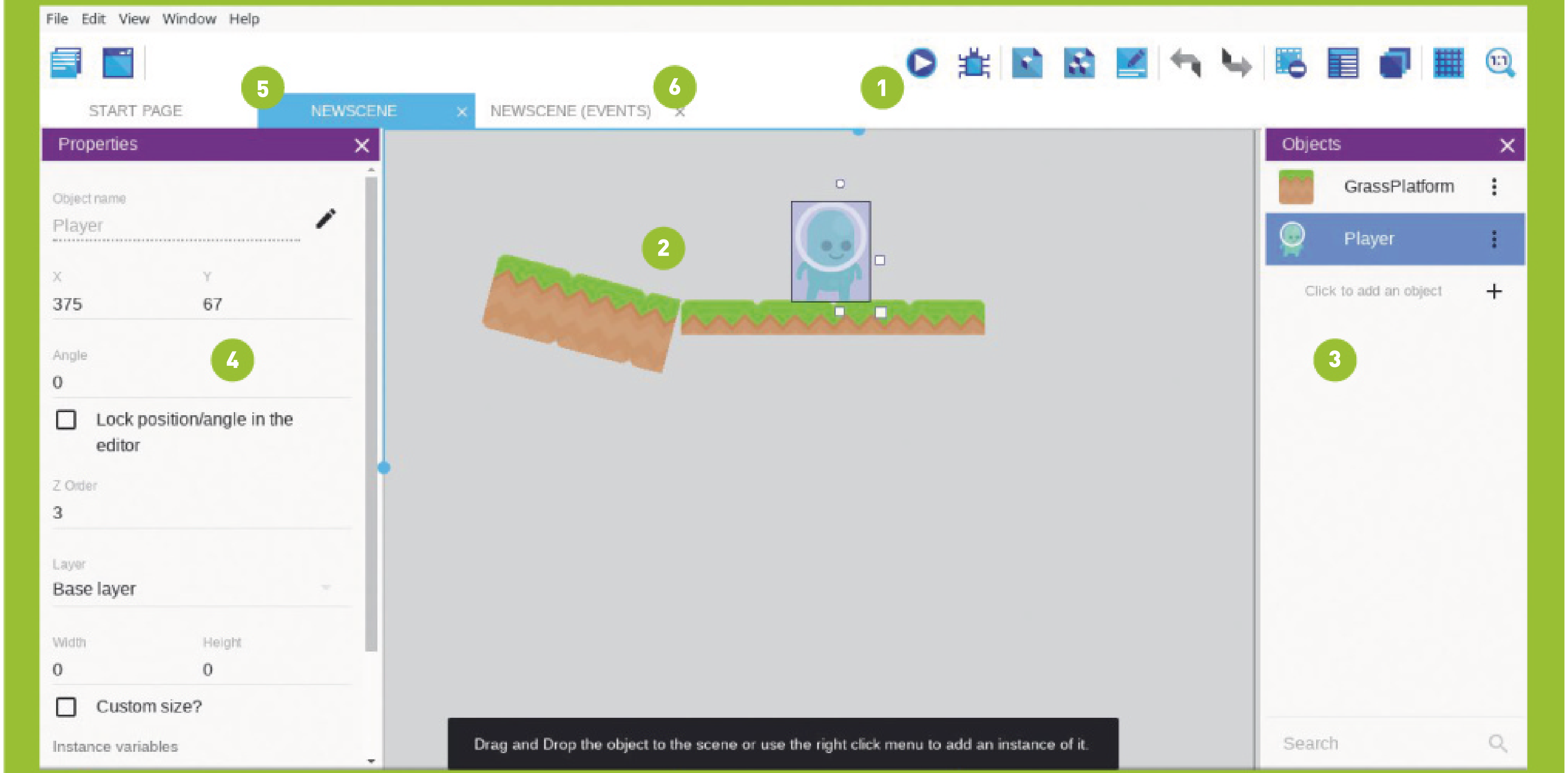
» Back in the "Properties" tab, you have the name for your object, as well as for any sprite animations. When you have some animation loaded, you can fine-tune the controls with looping options, speed controls, and a handy preview function. If you're starting with a blank object, click the "+" sign on the right to add an animation. You can have multiple animations, each with independent names, speeds, and looping controls.

» If you already have some image files to work with, click the "+" sign on the left to open a file browser, and choose whatever you want. Otherwise, to just start drawing your own frames, select "Edit with Piskel," which opens GDevelop's sprite editor.

» Crucial to game making are "Edit Hitboxes" and "Edit Points." Hitboxes are invisible zones that define a sprite's collision detection. If you disable the two sliders that share boxes across all sprites and animations, you can have independent hitboxes for each frame. This allows more refined collision detection, vital for something like a *Street Fighter*-style game, where each frame has a vastly different collision area.

» Click "Use a Custom Collision Mask" to edit your hitbox, where you position red nodes to define your

EXPLORE THE GDEVELOP INTERFACE



Object name
Player

X 375
Y 67

Angle
0

☐ Lock position/angle in the editor

Z Order
3

Layer
Base layer

Width 0
Height 0

☐ Custom size?

Instance variables

Drag and Drop the object to the scene or use the right click menu to add an instance of it.

1. MAIN TOOLBAR
This is where the chief buttons are, although they change depending on the open tab. Thankfully, the "Play" button is always here.

2. SCENE EDITOR
The main playing field, where you design and construct your levels. The mouse wheel zooms in and out.

3. OBJECTS PANEL
Create objects for your game here, then click-and-drag them on to the scene in the middle.

4. PROPERTIES PANEL
This panel can get in the way sometimes, but remember that it's here when you want to tweak an object's behavior.

5. FUNCTION TABS
These tabs jump between the main section of the program and completely change which buttons are on screen.

6. EVENT EDITOR
Open this tab to do the boring stuff, constructing the logic behind your game (it depends what floats your boat, really…).

shape. Add more nodes by clicking the "+" sign in the black circle. The more nodes, the more complex a shape you can define.

» "Edit Points" enables you to create special positions on a sprite, such as the end of a turret or the position from which an object rotates. You can have multiple points for each character, allowing for highly detailed objects with multiple weapons or abilities.

» The initial controls are quite similar to "Edit Hitboxes," in that you can choose whether to have independent points across frames, or whether to share them across all animations. The standard options are just "Origin" and "Center," but if you click the "+" sign, you can add your own custom points, such as a muzzle flash, for instance, and name them anything you like.

3 READY PLAYER ONE?

It would be tempting to work from a template, but it will be better to show you how GDevelop operates by starting from scratch. From the opening screen, choose "Create a New Project." A menu appears with a bunch of templates to choose from; choose the "Empty game" option. Make sure you choose where the folder will be, or it will be a nightmare finding it again.

» Back in the "Start Page" tab, it almost looks the same as the welcome screen, so it's easy to miss that the first button has changed from "Open a Project" to "Open Project Manager." This enables you to modify the global settings of the game, such as the order of your levels, for instance. This is mostly beyond the scope of this article, but remember it's there when your game starts to grow.

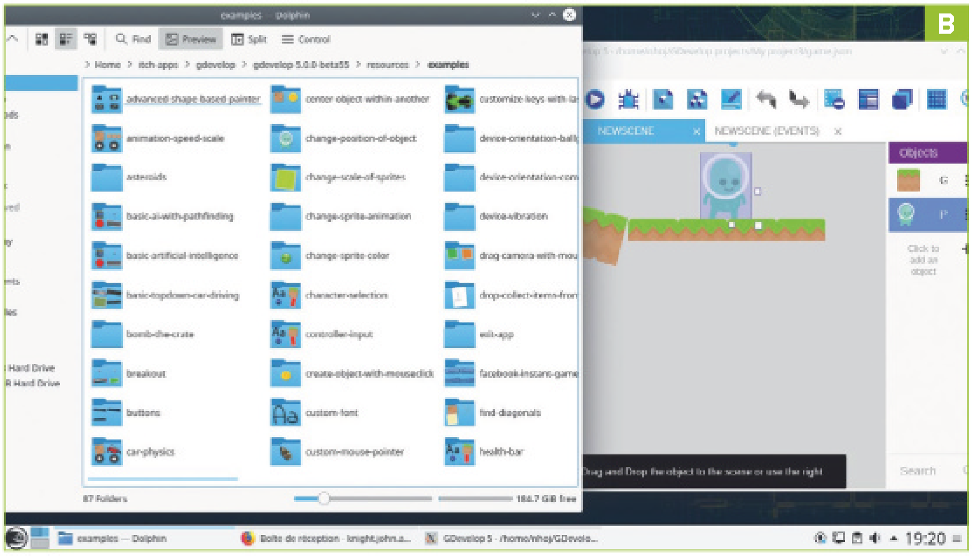
» For now, go to the "Project" panel on the left, and under "Scenes," click the "+" sign to add a new scene. Click the entry that says "New Scene," and it opens in the "New Scene" tab in the main window. The "Project" panel will just be in the way for now, so feel free to close it if it's bugging you.

» For the moment, we'll just do the easy prep work, creating a series of objects and animations, which we will then program later. We're relying on the fact that you'll probably have the tutorial files installed (along with all their graphics), but if you don't have the files we mention, you can just draw your own.

4 YOUR PLATFORM

From the "Objects" panel, add a new object. You need to differentiate your platform from a regular character, so from the new window, choose "Tiled Sprite." The "Properties" window pops up with the boring name "NewObject." Rename it to "GrassPlatform."

» Now, to give the platform graphics, click in the "Select an image" field, and a drop-down appears with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examples — Dolphin
Find
Preview
Split
Control
Home › itch-apps › gdevelop › gdevelop-5.0.0-beta55 › resources › examples
advanced-shape-based-painter
animation-speed-scale
asteroids
basic-ai-with-pathfinding
basic-artificial-intelligence
basic-topdown-car-driving
bomb-the-crate
breakout
buttons
car-physics
center-object-within-another
change-position-of-object
change-scale-of-sprites
change-sprite-animation
change-sprite-color
character-selection
controller-input
create-object-with-mouseclick
custom-font
custom-mouse-pointer
customize-keys-with-la
device-orientation-ball
device-orientation-com
device-vibration
drag-camera-with-mou
drop-collect-items-fron
exit-app
facebook-instant-game
find-diagonals
health-bar
Hard Drive
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NEWSCENE
NEWSCENE (EVENTS)
Objects
Click to add an object
Drag and Drop the object to the scene or use the right
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examples — Dolphin
Boîte de réception - knight.john.a...
GDevelop 5 - /home/nhoj/GDevelo...
19:20

the entry "Choose a new image." If you can find GDevelop's installation folder, your sample images are under "resources/examples/platformer." Choose "Grass.png," then back in the "Properties" window, click "Apply."

» You can now place your platform somewhere in the playing field. Click and drag the platform into the center, and just dump it wherever you feel is best. You now have a tile of a grass platform, but that's not much use, so now let's demonstrate the program's coolest feature.

» If you click the platform, some little white boxes appear—these are resize controls. Click and drag them, and GDevelop generates more platforms based on the pattern of the original. Cooler still, the top box is a rotational control, allowing for platforms of any angle.

» Unfortunately, we still need to tell GDevelop this is a platform, otherwise your character will fall through it. In the "Objects" panel, right-click "GrassPlatform," and choose "Edit object." In the new window, open the "Behaviors" tab, and click the "+" sign on the right to add a behavior. In the new window, click "Platform," then click "Apply" in the window that follows. Now you have a platform to walk on, let's put something on it.

5 GIVE IT CHARACTER

We'll prepare the main character by assigning controls, then use images from the tutorials to make the character run and stand still. To create a new character, add a new object from the "Objects" panel. In the new window, click "Sprite," which opens "Properties" for the new character, and renames it "Player."

» To assign controls to "Player," click the "Behaviors" tab, and on the right is a "+" sign to add behaviors. From the new menu, choose "Platform character," which brings up a new screen of settings. We'll just use the defaults for now, so click "Apply."

PISKEL
THE ANIMATION EDITOR

Sometimes GDevelop can get obtuse, but Piskel is relatively straightforward. The central area is where you draw, the checkered gray background signifying transparency. If you want to create a series of images based on an initial template, draw your first image and then add the number of frames you want to fill. In the "Transform" box, you can now click the "Clone" icon.

To see your work, toward the top-right corner is a preview window showing all of the animation frames playing in sequence. If you look just below the previewer, there is a slider showing the number of FPS (frames per second). When you're done, click "Save to GDevelop" over in the far top-right corner.

» Now to give "Player" some animation. From the "Objects" panel, right-click "Player," and choose "Edit object," which opens the "Properties" tab. We need two lines of animation, so click the "+" sign on the right twice. You now have two unnamed lines of animation, called Animation #0 "Idle" and Animation #2 "Running."

» To choose the animation images, click the big white square on the left with a "+" sign, which opens a file browser window, and open the same platformer folder as before. For the "Idle" animation, load "p1_stand.png." The "Running" animation is made of five images, so create five frames, and load the images "p1_walk03.png" through to "p1_walk07.png."

» There's just one last tweak we need to make before moving on. With the "Running" animation, click "Don't Loop," so that it changes mode to "Loop," and with the timer icon, delete the "1" and change it to "0.05," which will speed up the animation.

6 MAIN EVENT

Now for the hard bit. Open the "New Scene (Events)" tab [**Image C**], and you'll be in the event editor. This is the nitty gritty, the nuts and bolts, the engine room of gaming.

» Events are made of Conditions (on the left) and Actions (on the right). If a condition is true—for instance, "Laser is in collision with Enemy"—it triggers an action, such as "Delete object Enemy."

» A chain of these events is what's known as an algorithm, and these algorithms are ultimately the design that makes a videogame work. As you'll discover, the algorithms required for a game can quickly become complex, even for seemingly basic functions.

» For instance, can a platform be grabbed? How do you make it "grabbable"? What changes need to be made to the character, and what effect will this have on the game physics? Working this stuff out can be a nightmare, but thankfully, GDevelop has a selection of typical genre-specific behaviors that have been pre-programmed for you, and are ready to use.

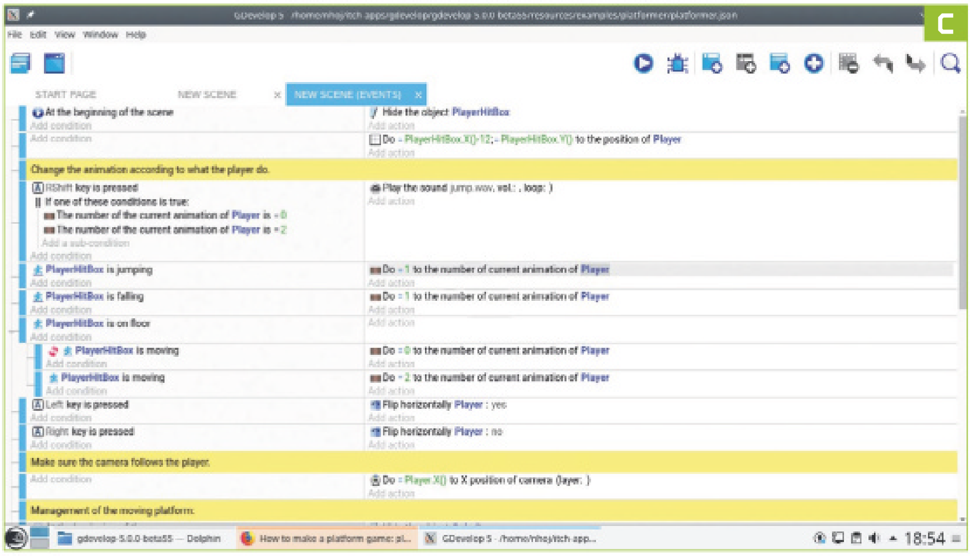
» To make your first event, click the "Add a new empty event" button from the toolbar. With the new empty event showing, click "Add condition." Our first bit of coding is to check whether the player is on the floor (aka the platform). A large menu appears with all of the conditions available in GDevelop. Scroll down to "Platform Behavior" and choose "Is on floor."

» On the right is where you assign an object to this behavior, and configure any parameters. Click in the "Object field" and an auto-complete menu appears with all the in-game objects. Choose "Player" and click outside the field to make it go away. This is all that's needed, so click "OK" to return to the event editor.

7 A SUBEVENT

Normally here, we would follow the usual chain of adding an action to go with the condition, but we'd much rather take the opportunity to demonstrate subevents. You could use two normal events to fill in the logic that:

● If the player is on the ground and not running, the "Idle" animation must play.


C

```
At the beginning of the scene          Hide the object PlayerHitBox
                                       Do =PlayerHitBox.X()-12;=PlayerHitBox.Y() to the position of Player
Change the animation according to what the player do.
RShift key is pressed                  Play the sound jump.wav, vol.: , loop: )
If one of these conditions is true:
  The number of the current animation of Player is =0
  The number of the current animation of Player is =2
PlayerHitBox is jumping                Do =1 to the number of current animation of Player
PlayerHitBox is falling                Do =1 to the number of current animation of Player
PlayerHitBox is on floor
  PlayerHitBox is moving               Do =0 to the number of current animation of Player
  PlayerHitBox is moving               Do =2 to the number of current animation of Player
Left key is pressed                    Flip horizontally Player : yes
Right key is pressed                   Flip horizontally Player : no
Make sure the camera follows the player.
                                       Do =Player.X() to X position of camera (layer: )
Management of the moving platform.
```

File Edit View Window Help
START PAGE
NEW SCENE
NEW SCENE (EVENTS)
Add condition
Add action
Add a sub-condition
gdevelop-5.0.0-beta55 — Dolphin
How to make a platform game: pl...
GDevelop 5 - /home/nhoy/itch-app...
18:54

● If the player is on the ground and running, the "Running" animation must play.

›› However, if you use subevents, you only need check whether the player is on the ground once, which makes the code cleaner and easier to troubleshoot.

›› To create a subevent, go to the "Player is on floor" event, right-click the blank space next to "Add a condition," and choose "Add Sub Event." Do this twice, because you need two subevents. The GUI works the same for these as normal events, although GDevelop indents them for visual differentiation.

›› For the first subevent, add a condition to check if the player is running by clicking "Add condition," "Platform Behavior," "Is moving," and choosing "Player" for the "Object" field. That's fine for now, so click "OK" to return to the event editor.

›› Now repeat the process for the second subevent, but this time check the slider that says "Invert condition." This very clever feature does the opposite of the programmed event, meaning that the first subevent checks whether the player is moving, and the second checks whether the player is not.

›› Now to finish the demonstration by adding actions that change the animations. For the first subevent, choose "Add action," and a similar screen appears as before, this time displaying all available actions instead of conditions.

›› The character and all its animations are what's known as a sprite object, so choose the "Sprite" category, and from the submenu, choose "Animations and images," followed by "Change the animation (by name)" from the final submenu. Choose "Player" from the "Object" field, and in the "Animation name" field, type "Running" including the double-quotes, or you'll get an error, and you'll probably need the capital letter as well.

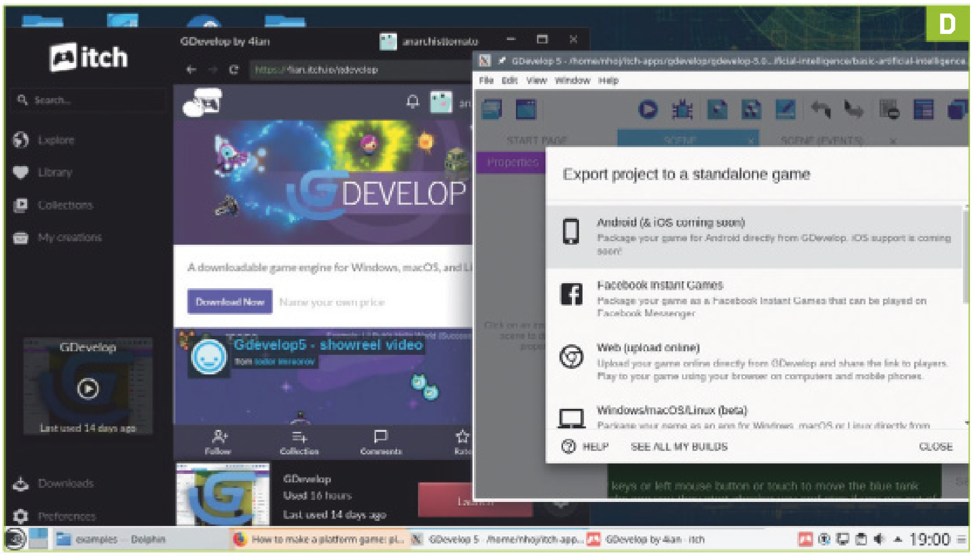
›› Unfortunately, you can't just hit Enter when you're done, because it'll just create another line of input, so annoyingly you need to click somewhere in the blank white space below to finish. Click "OK" and you're taken back to the event editor. For the second subevent, repeat the process, but this time make the animation name "Idle"—again, include the quotes. With that your demo should be ready to try, so save your work, then hit "Play" at will.

›› GDevelop's export abilities are awesome, because they make it possible for you to sell your games on anything you like. They're particularly fond of Itch (https://itch.io) [**Image D**].

›› The interface has come a long way in recent years, too, and is certainly worth considering by anyone wanting to make 2D games quickly. That said, it is still quite rough around the edges, particularly when it comes to the GUI. Things like needing to click outside a field into blank space may be fine for its developers, but ultimately this is a clumsy way to operate, and isn't exactly professional. Everything also seems to have multiple names—just pick a term and stick with it.

›› Furthermore, the claim that you don't need to know how to code isn't absolutely true: The event editor is basically programming with a GUI, and sometimes there are things you have to enter that are just bits of programming string with a GUI in the way.

›› However, don't let us give you the impression that this is a bad program. Although it's hard to recommend to novices, GDevelop's closer-to-code approach may be exactly what intermediate users are chasing. The balance between GUI and code seems to make more advanced forms of gaming possible, and if you look at some of the games that have been made already, there are some genuinely spectacular results. So, not perfect, but definitely worth a go nonetheless. A few major releases down the road, and GDevelop is going to be properly brilliant. ⏻


D

Export project to a standalone game

Android (& iOS coming soon)
Package your game for Android directly from GDevelop. iOS support is coming soon!

Facebook Instant Games
Package your game as a Facebook Instant Games that can be played on Facebook Messenger

Web (upload online)
Upload your game online directly from GDevelop and share the link to players. Play to your game using your browser on computers and mobile phones.

Windows/macOS/Linux (beta)

A downloadable game engine for Windows, macOS, and Li

keys or left mouse button or touch to move the blue tank

itch
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Last used 14 days ago
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Comments
Downloads
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Used 16 hours
Last used 14 days ago
GDevelop 5 - /home/nhoy/itch-apps/gdevelop/gdevelop-5.0...ficial-intelligence/basic-artificial-intelligence
File Edit View Window Help
START PAGE
SCENE
SCENE (EVENTS)
Properties
HELP
SEE ALL MY BUILDS
CLOSE
examples — Dolphin
How to make a platform game: pl...
GDevelop 5 - /home/nhoy/itch-app...
GDevelop by 4ian - itch
19:00

COOL GDEVELOP EXTRAS

With GDevelop being based on JavaScript, you can also add your own custom JavaScript coding. If you open the event editor, click "Choose and add an event" (the biggest "+" sign toward the right), and then "JavaScript code." This will be treated like any other event, and will be triggered each time the event is reached. Check the documentation for some examples, such as fading out a sprite when it hits the floor.

Not only does GDevelop support mobile platforms (currently Android and partial support for iOS), but for the gaming capitalists out there, you can even put in your own ad space with AdMob, and control where it's placed.

You can also enable the vibrate function on smartphones and control how long it lasts. We won't ask you what you use it for, but let's just assume it's for representing earthquakes and explosions.

It's well worth reading the documentation for publishing advice, because there's detailed information for every platform, as well as links to shared resources you can use to save having to do things such as sound or artwork. There's even advice for how to publish your game on Google Play.

Master Windows Remote Access

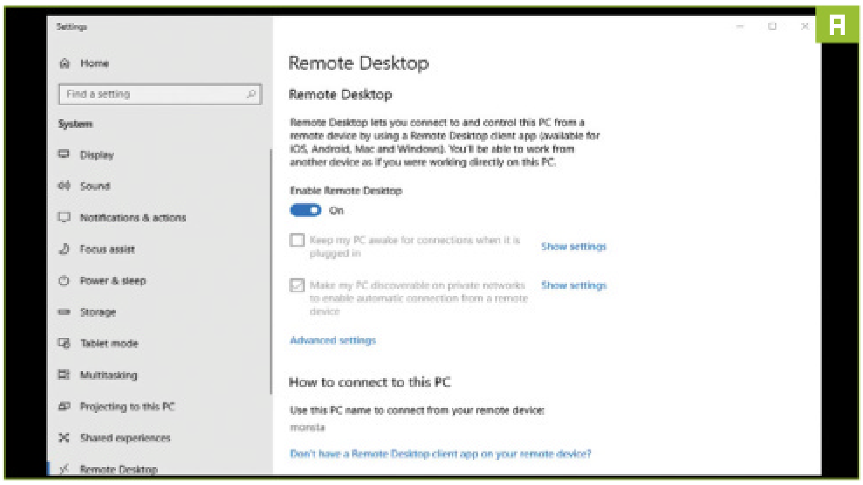
YOU'LL NEED THIS

WINDOWS PC
The Windows system you are trying to access needs to be a "Pro" edition.

CELL PHONE
With data, for testing an external port connection.

YOU'RE OVER HERE, but the system you want to access is over there. Surely modern computing has a solution? Of course it does. Meet Windows Remote Desktop Protocol, aka RDP, the Microsoft remote access client that's been included by default since Windows XP. It's a service that enables you to remotely log in to a networked Windows PC as though you were sitting in front of it. It's great for accessing headless servers, or just for lazy people who can't be bothered to go to the next room to sort out grandma's PC problem.

It's not the only remote desktop technology; the open-source VNC is good, but it has to capture and stream the entire desktop image. Windows RDP can get away with capturing just the underlying data structure to locally recreate the Windows desktop more efficiently. It also ties into the Windows Groups and User system, so is pretty secure, as you can restrict access to a RDP user who's connecting over the Internet. It features 128-bit encryption, redirection of the clipboard, audio, and a host of other devices. There are some restrictions on what versions of Windows can instigate a RDP server, but most can access a server once running. Microsoft added a new Remote Desktop Control Panel and Windows Store app with the Fall Edition update of Windows 10, but it retains the legacy tools, and we'll try to mention all options. **–NEIL MOHR**



Remote Desktop

Remote Desktop

Remote Desktop lets you connect to and control this PC from a remote device by using a Remote Desktop client app (available for iOS, Android, Mac and Windows). You'll be able to work from another device as if you were working directly on this PC.

Enable Remote Desktop
On

☐ Keep my PC awake for connections when it is plugged in — Show settings

☑ Make my PC discoverable on private networks to enable automatic connection from a remote device — Show settings

Advanced settings

How to connect to this PC

Use this PC name to connect from your remote device:
monsta

Don't have a Remote Desktop client app on your remote device?

1 CHECK THE WINDOWS VERSION

The version of Windows you have and what you're trying to do is important. Typically, "Home" versions only have the client software, which enables you to access a system. Any system you want to access needs the server software, which is only included with "Pro" and enterprise releases. So, if you're having issues finding an option or getting access, check it's the correct release.

›› Along similar lines, each successive release of Windows introduced a newer version—usually backward compatible—but again, if you find issues connecting with incompatible encryption schemes, it's probably an outdated client.

2 ACCESS ISSUES

For Microsoft "reasons," only a single user can be logged in to Windows at a time—even if they're different user accounts. So, if someone is using a system while you're trying to gain remote access, they'll get a friendly message enabling them to block access or allow it.

3 KEEP IT PRIVATE

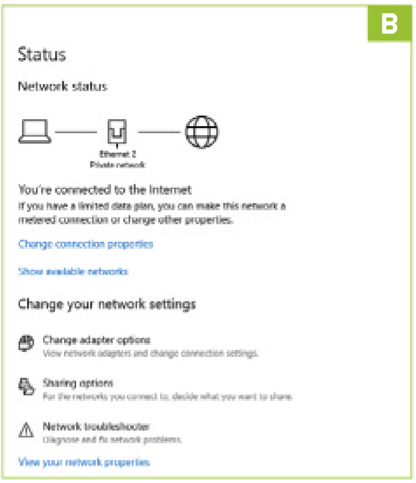
With those caveats out of the way, before starting anything, we need to set Windows so it'll accept Windows RDP connections. The latest Windows 10 has a dedicated Control Panel—open the Start menu, type "Remote Desktop," and select the Control Panel. Click the "Enable" switch [**Image A**], and you're away. On older Windows versions, you need to open Explorer, right-click "This PC," choose "Properties," select "Remote settings," and in the "Remote Desktop" section, select the middle "Allow" option.

›› RDP only works over a network marked as "Private." For security reasons, if it's in Public mode, no access is allowed (on occasion, we've had Windows switch to "Public" on our home network). To ensure it's a "Private" network, click the Network icon in the Notification area, select "Network & Internet Settings," change the connection properties, and choose "Private" [**Image B**].

4 PERMISSIONS AND PASSWORDS

You should notice a "User accounts" link a little further down. You can use this to add existing users for remote access, and they'll use their own passwords and accounts. However, for security over the Internet, you might consider creating a dedicated user account with restricted permissions.

›› Do bear in mind that because anyone can potentially access this over the Internet, you should choose a complex username with a strong password. We've covered this before, but a long, memorable password is best, rather than a short random one, or even a short word with a number and capitalization.



Status

Network status

You're connected to the Internet
If you have a limited data plan, you can make this network a metered connection or change other properties.

Change connection properties

Show available networks

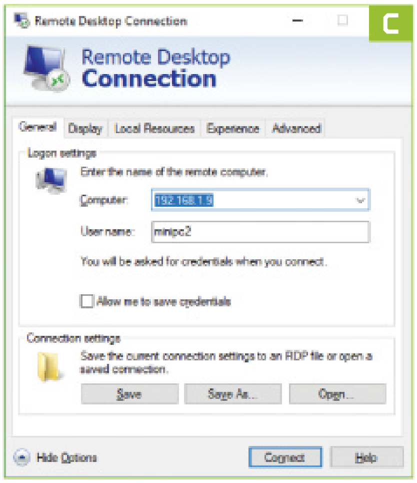
Change your network settings

Change adapter options
View network adapters and change connection settings.

Sharing options
For the networks you connect to, decide what you want to share.

Network troubleshooter
Diagnose and fix network problems.

View your network properties



Logon settings

Enter the name of the remote computer.

Computer: 192.168.1.9

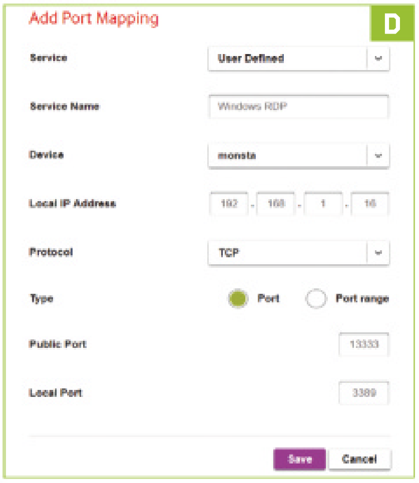
User name: minipc2

You will be asked for credentials when you connect.

☐ Allow me to save credentials

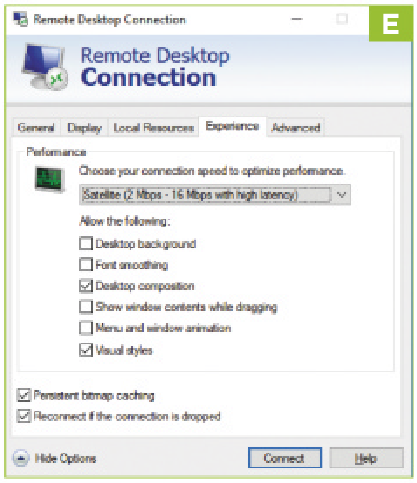
Connection settings

Save the current connection settings to an RDP file or open a saved connection.



Add Port Mapping

Service: User Defined
Service Name: Windows RDP
Device: monsta
Local IP Address: 192 . 168 . 1 . 16
Protocol: TCP
Type: ● Port ○ Port range
Public Port: 13333
Local Port: 3389



Performance

Choose your connection speed to optimize performance.

Satellite (2 Mbps - 16 Mbps with high latency)

Allow the following:

☐ Desktop background
☐ Font smoothing
☑ Desktop composition
☐ Show window contents while dragging
☐ Menu and window animation
☑ Visual styles

☑ Persistent bitmap caching
☑ Reconnect if the connection is dropped

5 TEST THE CONNECTION

Before continuing, you should test that RDP and any user account are working. Jump on another PC or RDP client, and attempt to log in over your home network. Open the Start menu, type "Remote Desktop Connection," and run. Enter the remote PC name, or ideally its IP address, to get going [**Image C**], then enter the username and password.

6 ADD SECURITY

Accessing your system over the Internet with RDP isn't the best of ideas—for anything even vaguely sensitive, you should use a third-party service that adds an additional layer of access security. You might even want to consider the Google Chrome Remote Access service, as an example.

›› That said, you can set up Windows RDP to run over the Internet with two main steps: finding the WLAN IP address of your Internet router, and forwarding port 3389 of your broadband router to your local PC.

›› Windows RDP works over TCP port 3389; ports used in TCP networking identify what service a data stream is associated with—for instance, 3389 is Microsoft RDP. To add security, we want to connect to the router over the Internet to a randomly selected port, making it far harder to hack. The available range of general ports is from 1024 to 65536. Depending on your router, configure it to forward that random port to the IP of your PC and to port 3389 [**Image D**].

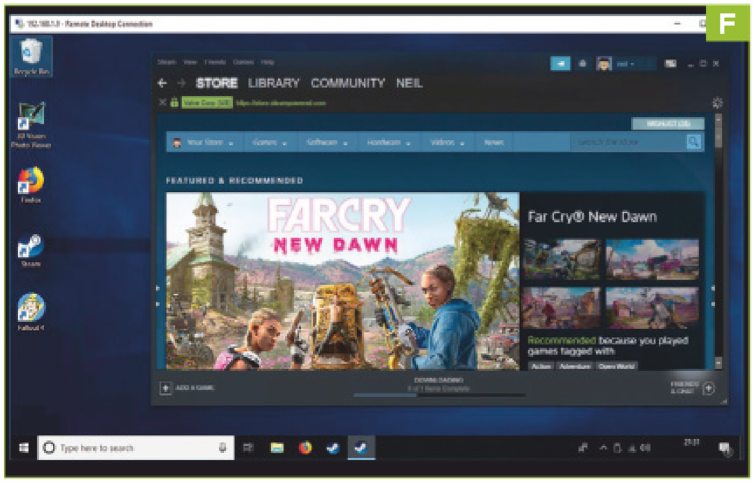
›› Again, this depends on your particular broadband router, but somewhere in its interface, it'll report the external IP address that has been assigned to your router by your ISP. Try under the "Logging" or "Internet" section. You can also Google "what's my IP," and Google will tell you. If you don't have a static IP, you need a DDNS service, such as the one at http://noip.com.

›› So, how do you connect to a remote desktop that's using its own port? If you run the Remote Desktop Connection program, under the "Computer" section, you need to enter the external IP of your router, then a colon, and then the port number. All of that with no spaces. Press the down arrow, and you can also add the username, ready to log in.

7 SPEED UP THE CONNECTION

You can adjust the visual complexity of the remote connection; click the "Experience" tab to see how you could speed up your remote desktop experience [**Image E**]. You can leave all the options off, but even "Visual styles" and "Desktop composition" don't slow things down too much. Under "Display," you can select to have a smaller resolution and reduce the color depth, but be warned: This can rearrange your desktop.

›› To really test this out, you need access to a connection that is external to your own home network. For many, the easiest option is to fire up your smartphone, and use it to create a wireless hotspot, or directly access the remote system from it using a suitable app—see the boxout below. This connects via the cellular network, so be aware that data charges might apply.



8 FIREWALL AND FINISHING

The Windows Firewall is pretty comprehensive, so you can restrict RDP access to systems from specific IP addresses. If you know these details, it can create a really secure option. Open the Start menu, type "Firewall," and select "Windows Defender Firewall → Advanced settings." Select "Inbound Rules → Remote Desktop → Scope," and set the IP here.

›› If you no longer require external access, there's a level of tidying up that will secure your system once again. First, remove the forward port from the router. Second, remove remote access privileges or the user entirely from the system. Finally, if you don't plan to use it, you can remove remote access completely, and disable access [**Image F**]. ⏻

ANDROID, IOS, & LINUX

So far, we've only talked in terms of access from other Windows systems, but Windows RDP clients exist for all systems, including Android and Apple iOS. Search for Parallels Client, an excellent free app. When first adding a connection, ensure you select the "Standard RDP" mode, otherwise configure it in the same way as the Windows RDP client, as explained in the main text. You can use the "Advanced" section at the bottom to tweak shared resources.

It adapts impressively well to portrait and modern cell phone displays, and has excellent text and pointer options. Plus, if you want secure remote access, there's a personal plan for $20 per year. Microsoft does offer its own client, and we suppose you could use that if you wanted as well. If you're working on a Linux system, you'll find that many VNC remote desktop clients offer an RDP option that enables access to your Windows box, too.

Accessing a Windows box on your cell phone is ridiculously simple.

Play Your Music with Winyl

YOU'LL NEED THIS

WINYL
Download this open-source app from https://winyl-player.github.io.

WINYL WILL APPEAL if you're looking for a no-nonsense, lightweight audio player for your digital music library. The app consumes around 22MB of memory in use—compare that to Windows Media Player (around 50MB), or Groove Music (over 100MB)—making it suitable for older and slower machines, such as two-in-one tablets. Despite this, Winyl still boasts handy features and a slick user interface to help you enjoy your music.

In this tutorial, we'll show you how to create your music library, plus change metadata (and artwork) using Winyl's handy tag-editing tools. You'll also learn how to customize the program, and make use of its playlists and smartlists, too. And if you're fed up with your own music, just select "Radios"from the "Library" pane to access hundreds of streaming radio stations spanning many genres and tastes. **–NICK PEERS**

1 DOWNLOAD AND SET UP

Go to https://winyl-player.github.io and click "Downloads" [**Image A**]. You can download a regular version of Winyl to install, or a portable version in ZIP format, the contents of which you can extract to your portable tools folder or USB drive. Once done, open Winyl from its Start menu shortcut, or—if you've extracted the portable version—by double-clicking "Winyl.exe" inside the Winyl folder.

2 SET UP LIBRARIES

You're prompted to point the program toward your music folder (or folders). Click "Add" to manually browse for—and select—the parent folder containing your music. If your music is scattered across multiple locations on your PC, click "Add" as many times as you need to select additional folders. When you're done, click "Update" [**Image B**], and wait for Winyl to scan through your music files.

3 REVIEW LIBRARY

Once the progress bar disappears, your screen will remain blank. Don't panic—expand the "Artists" link on the left, and you should see all your music organized by artist. Select one, and you should see a list of tracks organized into albums appear. You can also navigate by folder or genre—assuming music has been tagged as such—using the links on the left side of the window.

4 LISTEN TO YOUR MUSIC

Select a track or album, then click the "Play" button at the bottom of the window to start listening to it. Playback controls include skip back and forward, shuffle, repeat, and volume adjustment. Press F6 to open the Equalizer window to alter the sound using a 10-bar graphic equalizer with preamp and support for over 20 presets, from "Rock" and "Pop" to "Bass Reducer" [**Image C**].

5 EDIT LIBRARY INFORMATION

You can fix incorrect matches or add extra information to both entire albums and individual tracks. To update a single track, right-click it, and choose "Properties," or click an album title to select all the tracks, then right-click, and choose "Properties." Use the "Tags" tab to change the track or album's metadata [**Image D**]. Here we're adding the "Album Artists" tag to file the album correctly.

6 ADD ALBUM ART

Switch to the "Cover Art" tab [**Image E**] to review the current album art. Drag a photo from a folder or the Firefox web browser to the "Drag picture here" window to change it, or click "Google" to search for artwork based on the artist and album title (this doesn't work in the portable version). You can embed the artwork into the music file itself, or save it as a separate file.

7 CREATE A PLAYLIST

Create a compilation by adding favorite tracks or albums to playlists. Select each track or tracks (use Ctrl-click, or click an album header), then right-click, and choose "Add to Playlist → To New Playlist" [**Image F**] to create a new playlist named "Playlist DD/MM/YYYY." Add more tracks in the same way, this time choosing the playlist name under "Add to Playlist."

8 MANAGE PLAYLISTS

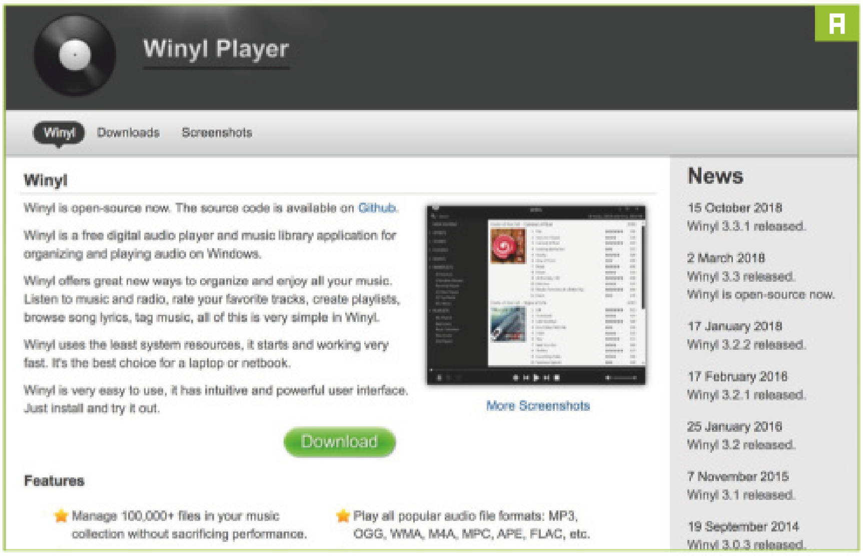
Manage your playlist from the left-hand pane under "Playlists." Start by right-clicking its name and choosing "Rename" to change it, or "Delete" to remove it. Select the playlist to view its contents and running order in the main pane. Click and drag a track to change its position in the running order, or right-click the track and choose "Delete" to remove it from the playlist.

9 USE SMARTLISTS

Smartlists are playlists automatically generated using rules or filters. Right-click "Smartlists" in the "Library" pane, then choose "New → Smartlist" to get started. A number of examples are included, from "50 Random tracks" to "25 Most Played" and "90s Music" [**Image G**]. Select one, and the selected tracks appear. Don't like the random choice? Click again to change it.

10 CUSTOMIZE WINYL

Press F4 to change the look of Winyl; there's a choice of six light or dark skins [**Image H**]. Open the "Settings" submenu to disable visual effects and smooth scrolling to improve performance on low-end machines, or select "Settings → Advanced" for more options, such as choosing what items appear in "Library," and the transparency of the mini player.


A
Winyl Player
Winyl
Downloads
Screenshots
More Screenshots
Download

Winyl

Winyl is open-source now. The source code is available on Github.

Winyl is a free digital audio player and music library application for organizing and playing audio on Windows.

Winyl offers great new ways to organize and enjoy all your music. Listen to music and radio, rate your favorite tracks, create playlists, browse song lyrics, tag music, all of this is very simple in Winyl.

Winyl uses the least system resources, it starts and working very fast. It's the best choice for a laptop or netbook.

Winyl is very easy to use, it has intuitive and powerful user interface. Just install and try it out.

Features

- Manage 100,000+ files in your music collection without sacrificing performance.
- Play all popular audio file formats: MP3, OGG, WMA, M4A, MPC, APE, FLAC, etc.

News

15 October 2018
Winyl 3.3.1 released.

2 March 2018
Winyl 3.3 released.
Winyl is open-source now.

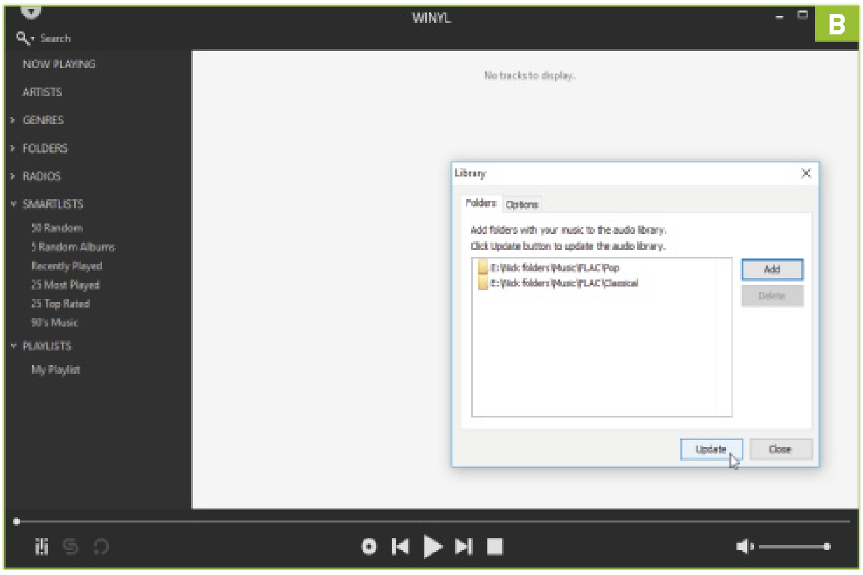
17 January 2018
Winyl 3.2.2 released.

17 February 2016
Winyl 3.2.1 released.

25 January 2016
Winyl 3.2 released.

7 November 2015
Winyl 3.1 released.

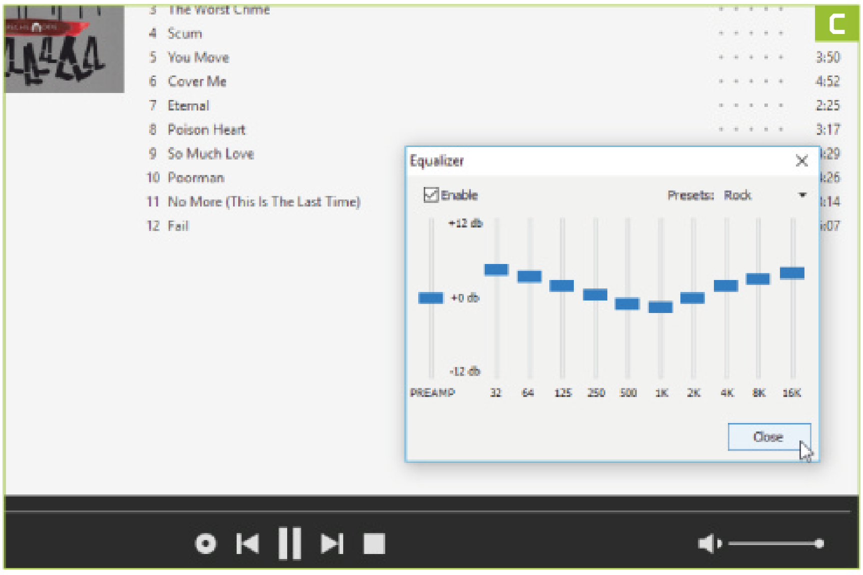
19 September 2014
Winyl 3.0.3 released.


B
WINYL
Search
NOW PLAYING
ARTISTS
GENRES
FOLDERS
RADIOS
SMARTLISTS
50 Random
5 Random Albums
Recently Played
25 Most Played
25 Top Rated
90's Music
PLAYLISTS
My Playlist
Library
Folders
Options
Add
Delete
Update
Close

No tracks to display.

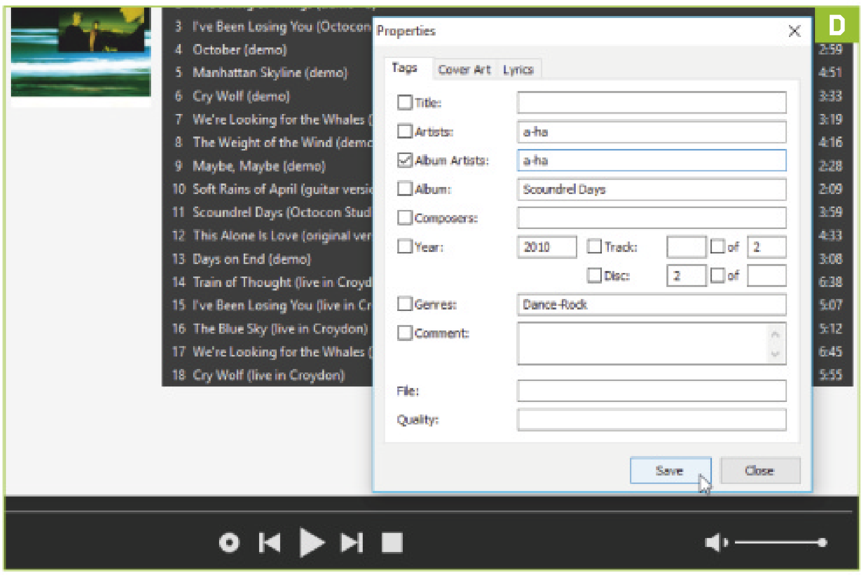
Add folders with your music to the audio library.
Click Update button to update the audio library.

E:\Nick folders\Music\FLAC\Pop
E:\Nick folders\Music\FLAC\Classical


C
Equalizer
Enable
+12 db
+0 db
-12 db
PREAMP
32
64
125
250
500
1K
2K
4K
8K
16K
Close

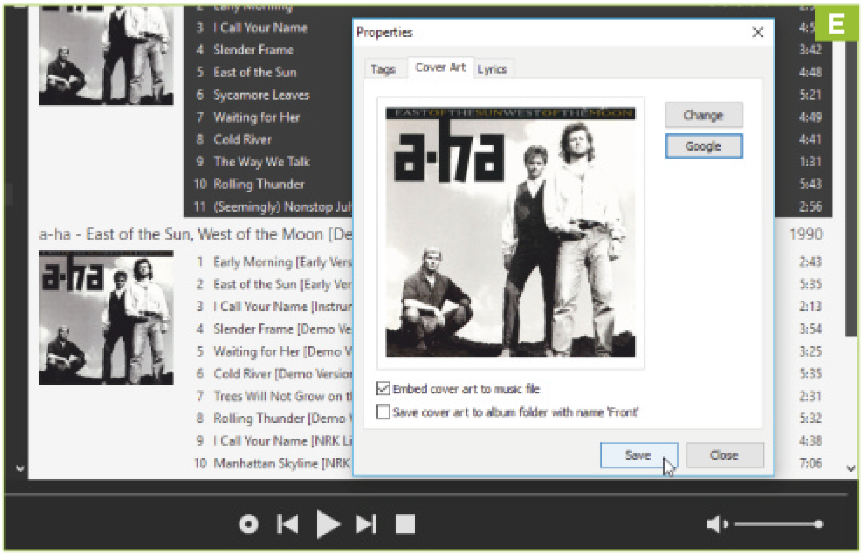
3 The Worst Crime
4 Scum
5 You Move 3:50
6 Cover Me 4:52
7 Eternal 2:25
8 Poison Heart 3:17
9 So Much Love
10 Poorman
11 No More (This Is The Last Time)
12 Fail

☑ Enable
Presets: Rock


D
Properties
Tags
Cover Art
Lyrics
Save
Close

3 I've Been Losing You (Octocon
4 October (demo) 2:59
5 Manhattan Skyline (demo) 4:51
6 Cry Wolf (demo) 3:33
7 We're Looking for the Whales (3:19
8 The Weight of the Wind (demo 4:16
9 Maybe, Maybe (demo) 2:28
10 Soft Rains of April (guitar versi 2:09
11 Scoundrel Days (Octocon Stud 3:59
12 This Alone Is Love (original ver 4:33
13 Days on End (demo) 3:08
14 Train of Thought (live in Croyd 6:38
15 I've Been Losing You (live in Cr 5:07
16 The Blue Sky (live in Croydon) 5:12
17 We're Looking for the Whales (6:45
18 Cry Wolf (live in Croydon) 5:55

☐ Title:
☐ Artists: a-ha
☑ Album Artists: a-ha
☐ Album: Scoundrel Days
☐ Composers:
☐ Year: 2010 ☐ Track: ☐ of 2
☐ Disc: 2 ☐ of
☐ Genres: Dance-Rock
☐ Comment:
File:
Quality:

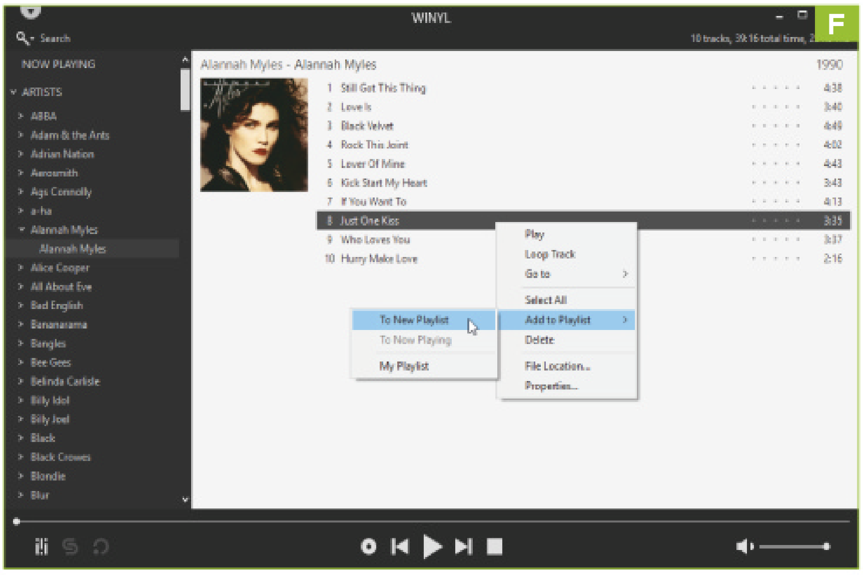

E
Properties
Tags
Cover Art
Lyrics
Change
Google
Save
Close

3 I Call Your Name
4 Slender Frame 3:42
5 East of the Sun 4:48
6 Sycamore Leaves 5:21
7 Waiting for Her 4:49
8 Cold River 4:41
9 The Way We Talk 1:31
10 Rolling Thunder 5:43
11 (Seemingly) Nonstop Jul 2:56

a-ha - East of the Sun, West of the Moon [De 1990

1 Early Morning [Early Vers 2:43
2 East of the Sun [Early Ver 5:35
3 I Call Your Name [Instrun 2:13
4 Slender Frame [Demo Ve 3:54
5 Waiting for Her [Demo V 3:25
6 Cold River [Demo Versio 5:35
7 Trees Will Not Grow on t 2:31
8 Rolling Thunder [Demo 5:32
9 I Call Your Name [NRK Li 4:38
10 Manhattan Skyline [NRK 7:06

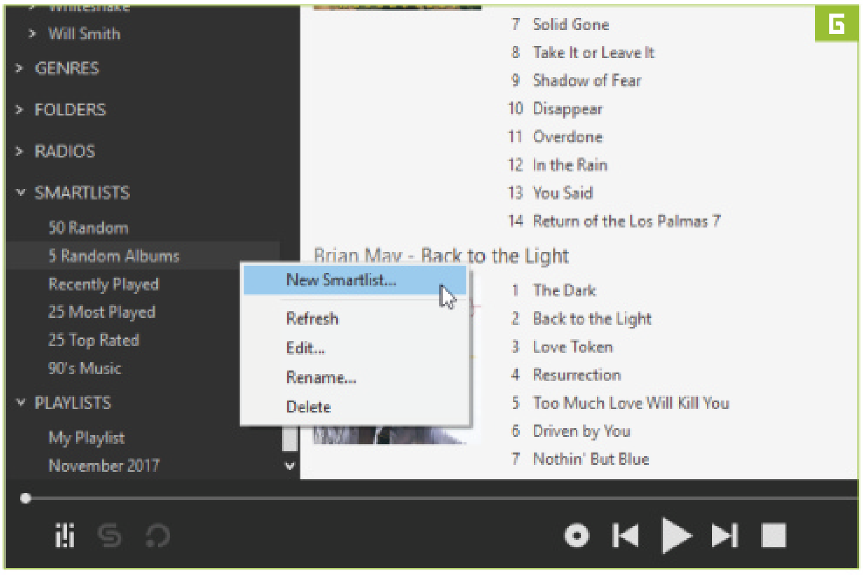
☑ Embed cover art to music file
☐ Save cover art to album folder with name 'Front'


F
WINYL
Search
NOW PLAYING
ARTISTS
ABBA
Adam & the Ants
Adrian Nation
Aerosmith
Ags Connolly
a-ha
Alannah Myles
Alannah Myles
Alice Cooper
All About Eve
Bad English
Bananarama
Bangles
Bee Gees
Belinda Carlisle
Billy Idol
Billy Joel
Black
Black Crowes
Blondie
Blur
To New Playlist
To Now Playing
My Playlist
Play
Loop Track
Go to
Select All
Add to Playlist
Delete
File Location...
Properties...

10 tracks, 39:16 total time,

Alannah Myles - Alannah Myles 1990

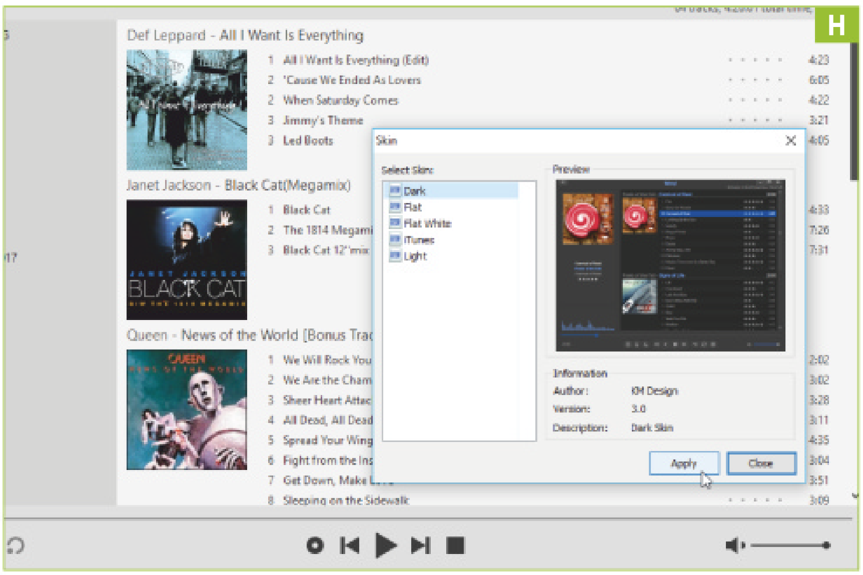
1 Still Got This Thing 4:38
2 Love Is 3:40
3 Black Velvet 4:49
4 Rock This Joint 4:02
5 Lover Of Mine 4:43
6 Kick Start My Heart 3:43
7 If You Want To 4:13
8 Just One Kiss 3:35
9 Who Loves You 3:37
10 Hurry Make Love 2:16


G
Will Smith
GENRES
FOLDERS
RADIOS
SMARTLISTS
50 Random
5 Random Albums
Recently Played
25 Most Played
25 Top Rated
90's Music
PLAYLISTS
My Playlist
November 2017
New Smartlist...
Refresh
Edit...
Rename...
Delete

7 Solid Gone
8 Take It or Leave It
9 Shadow of Fear
10 Disappear
11 Overdone
12 In the Rain
13 You Said
14 Return of the Los Palmas 7

Brian May - Back to the Light

1 The Dark
2 Back to the Light
3 Love Token
4 Resurrection
5 Too Much Love Will Kill You
6 Driven by You
7 Nothin' But Blue


H
Skin
Select Skin:
Dark
Flat
Flat White
iTunes
Light
Preview
Apply
Close

Def Leppard - All I Want Is Everything

1 All I Want Is Everything (Edit) 4:23
2 'Cause We Ended As Lovers 6:05
2 When Saturday Comes 4:22
3 Jimmy's Theme 3:21
3 Led Boots 4:05

Janet Jackson - Black Cat(Megamix)

1 Black Cat 4:33
2 The 1814 Megami 7:26
3 Black Cat 12' mix 7:31

Queen - News of the World [Bonus Trac

1 We Will Rock You 2:02
2 We Are the Cham 3:02
3 Sheer Heart Attac 3:28
4 All Dead, All Dead 3:11
5 Spread Your Wing 4:35
6 Fight from the Ins 3:04
7 Get Down, Make L 3:51
8 Sleeping on the Sidewalk 3:09

Information
Author: KM Design
Version: 3.0
Description: Dark Skin

Create Moving Smoky Hair with Video

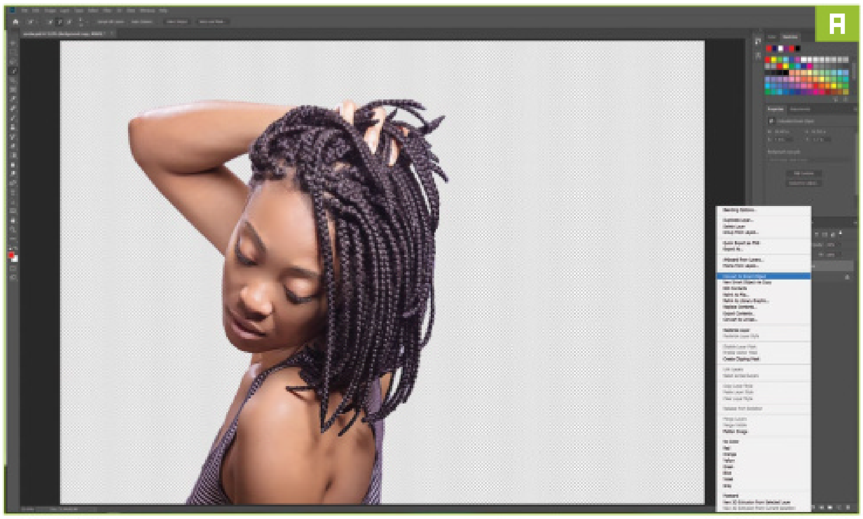
YOU'LL NEED THIS

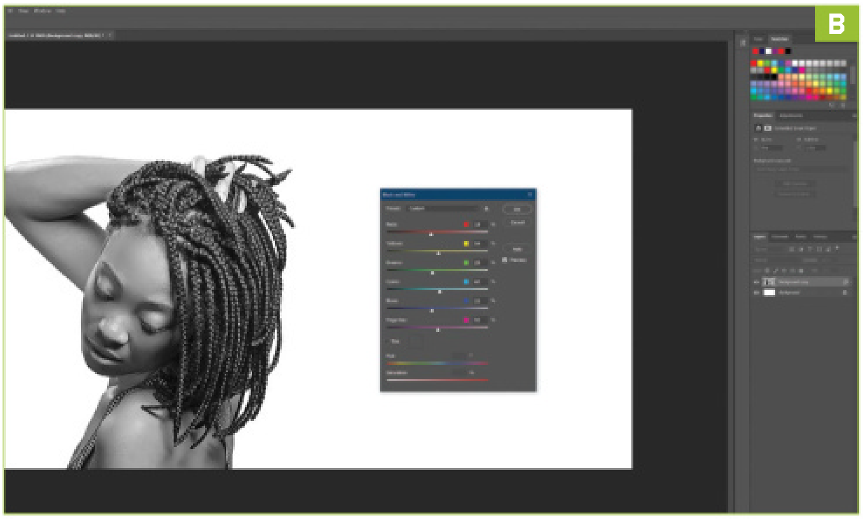
PHOTOSHOP
Subscribe to a suitable package at www.adobe.com.

MERGING TWO IMAGES TOGETHER, whether to fake the moon landings or create a double exposure effect, is one of the most basic things you can do with Photoshop. The app contains tools for layering the images, and using masks to gradually and carefully blend them together in such a way that you'd never know they'd ever been separate. We're taking things one step further, however, by merging an image with a video to create a short, looping, animated GIF.

You need a couple of source files for this, which you can take yourself or obtain from the public domain. The first needs to be a still image of a model, with an emphasis on their hair. The other needs to be a video of some smoke—one of those artistic ones photographers love to create with some sort of smoke, or suspended powder or ink in water, and some strobes. This is a fun project, and is quite satisfying when you get everything right.

The uses for such an animation are entirely up to you, but the ability to merge two different media together in this way is one of Photoshop's most powerful tricks. –**IAN EVENDEN**





1 CREATE A LAYER MASK

Start by selecting your model. You can use any of the selection tools you like here, but you need to select the model, not the background. Of course, if it's easier, you can select the background then use "Select → Inverse," because this has the same end effect. When you're happy, open "Select and Mask" from the "Select" menu, and tidy up the edges. Make sure your "Output" setting is "New Layer with Layer Mask," and hit "OK." You're left with two layers: your original Background, which is hidden, and the new, backgroundless, cutout of your model.

2 SMART OBJECT

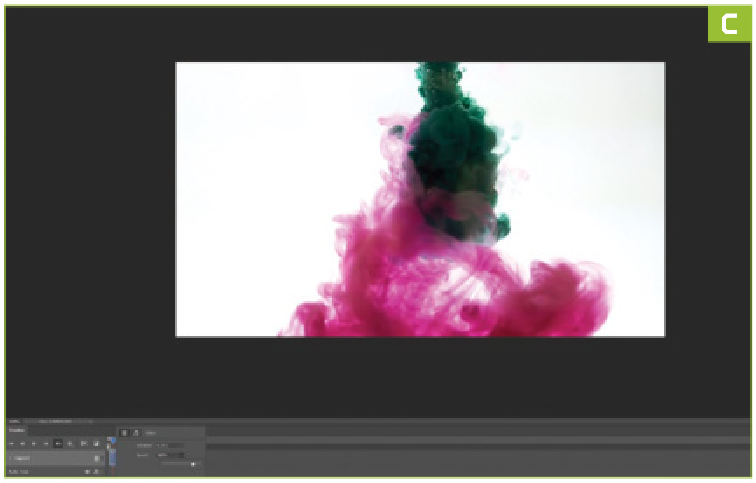
Turn the top layer into a Smart Object by right-clicking its entry in the Layers palette, and choosing "Convert to Smart Object" [**Image A**]. Doing this makes it easier to move the layer to another image file and continue to manipulate it without losing quality, as the Smart Object uses the original document as a reference. Some filters and effects don't work on Smart Objects, so at some point we're going to rasterize the layer, removing its Smart Object properties.

3 NEW DOCUMENT

Create a new document at a reasonable resolution for a GIF, such as 1280x720px, and in RGB color. Drag the Smart Object layer from your original document into the new one, and use Free Transform (Ctrl-T) to shrink the object if needed. Click the "Maintain Aspect Ratio" toggle on at the top of the interface to make it easier. Position the model to one side of your document, so their hair is facing into the empty space.

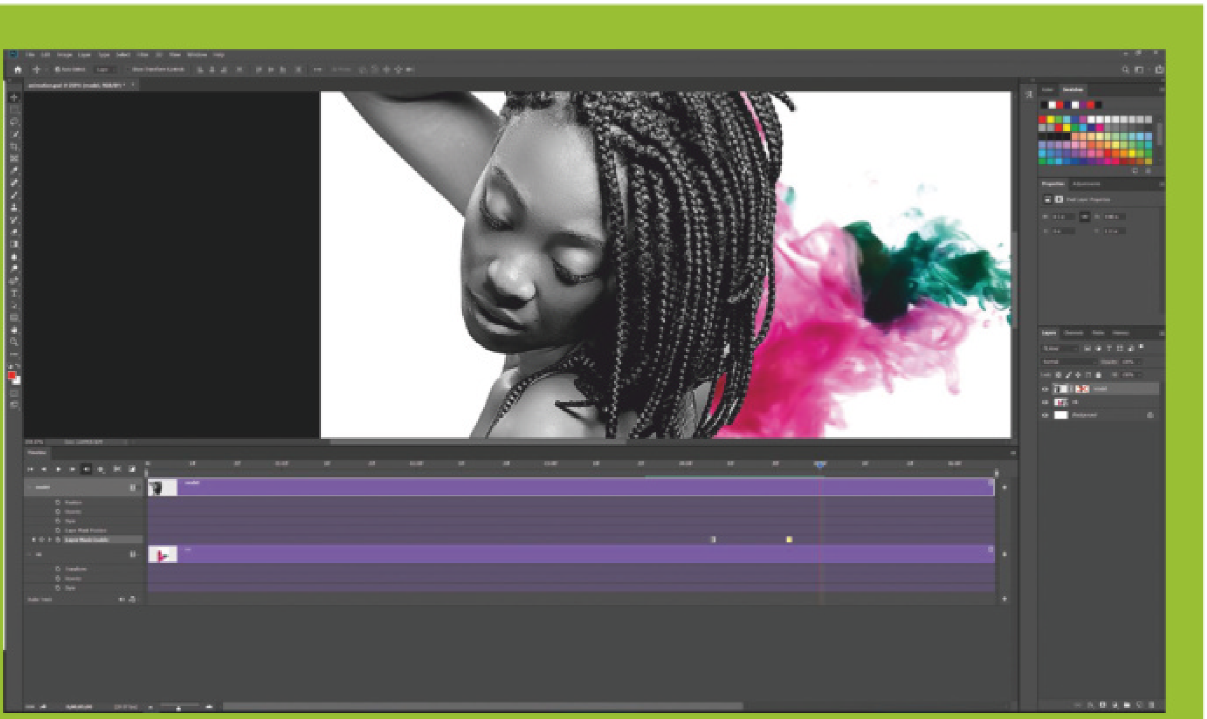
4 BLACK AND WHITE

This step is optional, but looks good. To make the layer monochrome, while leaving the image in its RGB color state, go to "Image → Adjustments → Black and White." This has advantages over the other common method (convert image to grayscale, then back to RGB), as it allows you to control the way your colors are mapped to shades of gray. Hit the "Auto" button to start with, then fine-tune the sliders until you get to a conversion that appeals to you [**Image B**].



MOVE MORE THAN PIXELS

Layer masks can also be animated, enabling you to reveal or hide parts of a layer as the animation proceeds. Go to the left of the Timeline, and click the arrow next to the layer you want to mask. If there's already a mask in place, it's listed here. The "Layer Mask Position" option enables you to move the mask, using keyframes, while "Layer Mask Enable" lets you switch masks on and off, again using keyframes you add with the yellow diamond button at the left.



5 OPEN THE VIDEO

Opening a video file in Photoshop is as simple as going to "File → Open" and choosing it. It opens as a new document, with the Timeline open at the bottom of the window [**Image C**]. Use the Timeline's Trim tool—drag in the ends of the video as it lays on the timeline—to make sure you're using only the portion of the video you want, and right-click it to adjust the playback speed if you need to. An animated GIF loops, so a quick and simple burst of animation is all you need.

6 VIDEO LAYERS

On the Layers palette, right-click to "Ungroup the Video Layers," then duplicate the remaining layer. Place the red line of the playback head near the center of this new clip on the Timeline—it should appear above the previous one—and use the scissors icon to the left to cut it in two. Switch the positions of the two new clips, so the ending is at the beginning and the beginning comes later on the Timeline. Leave a gap between them, and use the black/white square icon at the left to add a Fade transition, dragging it to the end of the start clip and the beginning of the end clip. What you've got now is a chopped-up version of your video, without a clear start or end. Use the settings gear icon to make the Timeline loop, and then hit play to watch it.

7 COMBINE LAYERS

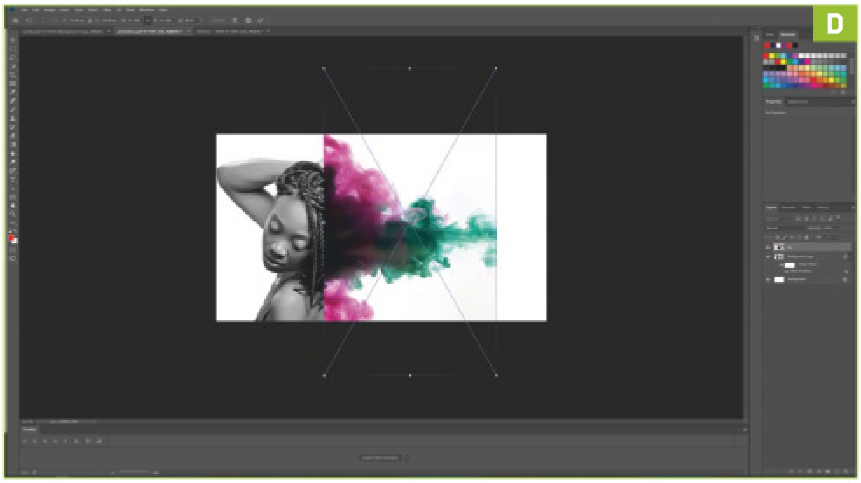
Hold Ctrl to select all three layers in your Layers palette, and right-click to combine them into one Smart Object. Drag this into the previous document, once again using Free Transform (Ctrl-T) to change its size and rotation to fit your model shot. Change the size of the model, too, if needs be—it's a Smart Object, so you can. Change the stacking order in the Layers palette so the model is in front of the video layer. On the Timeline ("Window → Timeline," if it's not open) choose "Create Video Timeline" (check the drop-down if it says "Frame Animation"), and drag out the duration of the model layer so it's the same as the movie layer [**Image D**].

8 BLEND

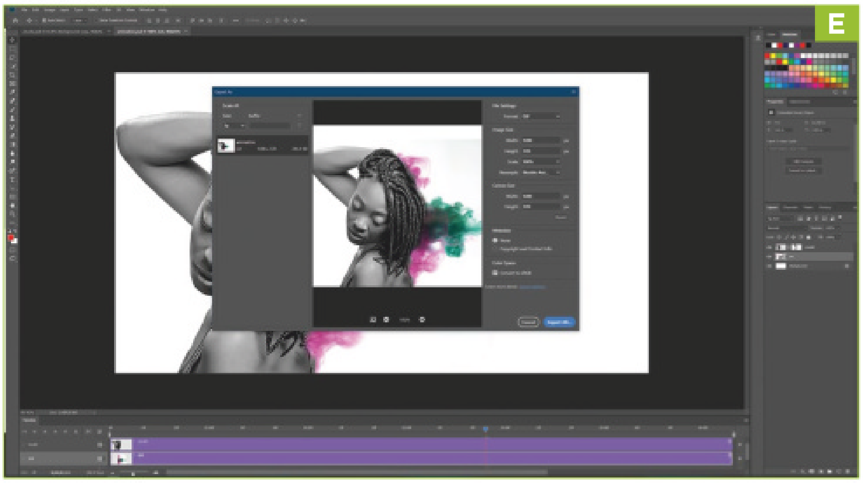
Rasterize the model layer from the right-click menu, then click "Add Layer Mask" from the bottom of the Layers palette. Using a soft, round brush, paint black over the edges of the model, so he or she blends into the video background. It's still possible to reposition and resize your video layer at this point. Press play on the Timeline to check how it looks. Using a Layer Mask on the video layer, and the same technique of painting with black, enables you to remove areas of the video you don't want to see.

9 EXPORT

"Save for Web" has been relegated to Legacy status in Photoshop CC. It's still there, but the "Export As" dialog ("File → Export → Export As") will soon completely take its place. Use this to export your file as an animated GIF (or animated PNG, if you're fancy, but file sizes can be larger) ready to use [**Image E**].



D



E

Stay Safe Online with a VPN

YOU'LL NEED THIS

VPN PROVIDER
There are lots to choose from, but we've gone with the free VPNBook (www.vpnbook.com).

VIRTUAL PRIVATE NETWORKS (VPNs) are a great way to protect your privacy online. Although they were originally designed to enable corporate employees to dial into their offices, VPNs are also really useful for guarding against snoopers and hackers, especially in countries where ISPs are obliged to record details of every website you visit.

The OpenVPN protocol is one of the best for this, because it encrypts the connection between your machine and a VPN provider using ultra-secure OpenSSL. If configured properly, anyone snooping on your Internet data only sees that you've connected to the VPN provider, not which sites you visit. You can also make it appear as though you're in a different country by using a VPN server based there. This guide will show you how to get OpenVPN up and running. **–NATE DRAKE**

1 CHOOSE YOUR VPN PROVIDER

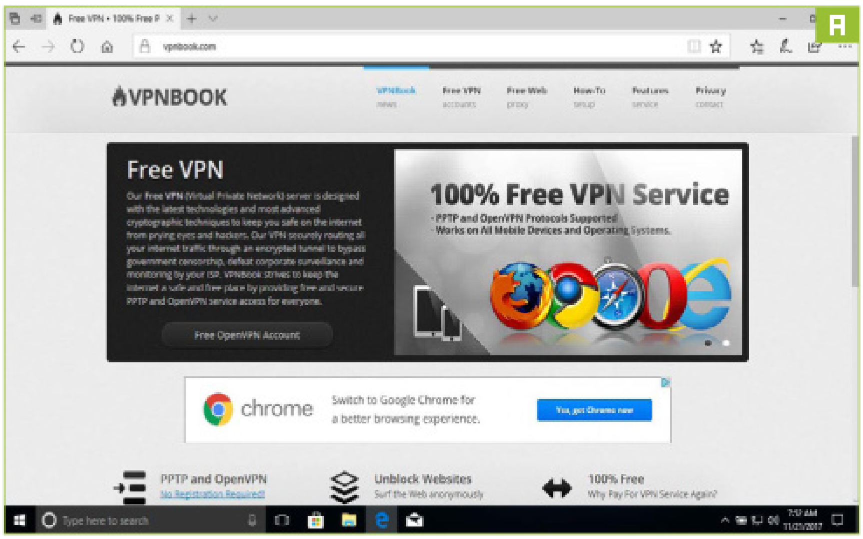
Use your search engine to find a VPN provider you like the look of. Most offer discounts for longer subscriptions. Make sure it specifically offers OpenVPN over other protocols. If you want to appear to be in a particular country, make sure it also has servers in that location. We've chosen VPNBook (www.vpnbook.com), which is free [**Image A**]. You can choose it, too, but its service isn't very fast.

2 CHOOSE YOUR PAYMENT METHOD

Most VPN providers accept payment by credit card and PayPal. However, this makes it easy to connect a particular account to your name. If you're feeling paranoid, consider using a VPN provider that accepts anonymous payment methods instead, such as Bitcoin. You can buy Bitcoins easily using online exchanges, such as BitStamp. See http://bit.ly/2AfDehB for more information.

3 DOWNLOAD OPENVPN CONFIGURATION FILE

Once you have registered with your chosen VPN provider, you'll be invited to download the OpenVPN configuration file. This is a small file with the extension .ovpn, which contains the settings that you'll need to connect to the service. If your VPN provider requires a username and password, note this down. VPNBook allows you to download the files you need and view the password without having to register first [**Image B**].


A
Free VPN • 100% Free P
vpnbook.com
VPNBOOK
VPNBook news
Free VPN accounts
Free Web proxy
How-To setup
Features service
Privacy contact
Free OpenVPN Account
chrome
Yes, get Chrome now
Type here to search
7:57 AM
11/23/2017

Free VPN

Our Free VPN (Virtual Private Network) server is designed with the latest technologies and most advanced cryptographic techniques to keep you safe on the internet from prying eyes and hackers. Our VPN securely routing all your internet traffic through an encrypted tunnel to bypass government censorship, defeat corporate surveillance and monitoring by your ISP. VPNBook strives to keep the internet a safe and free place by providing free and secure PPTP and OpenVPN service access for everyone.

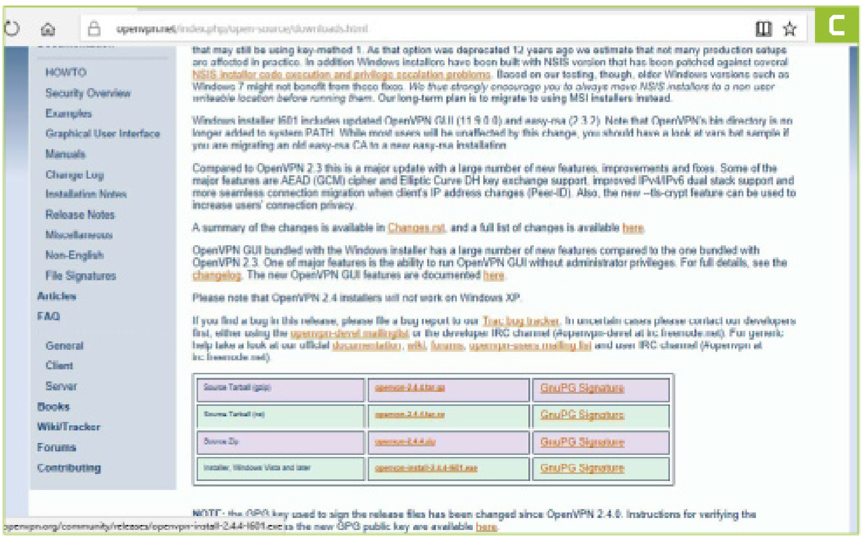
100% Free VPN Service
-PPTP and OpenVPN Protocols Supported
-Works on All Mobile Devices and Operating Systems.

Switch to Google Chrome for a better browsing experience.

PPTP and OpenVPN
No Registration Required!

Unblock Websites
Surf the Web anonymously

100% Free
Why Pay For VPN Service Again?

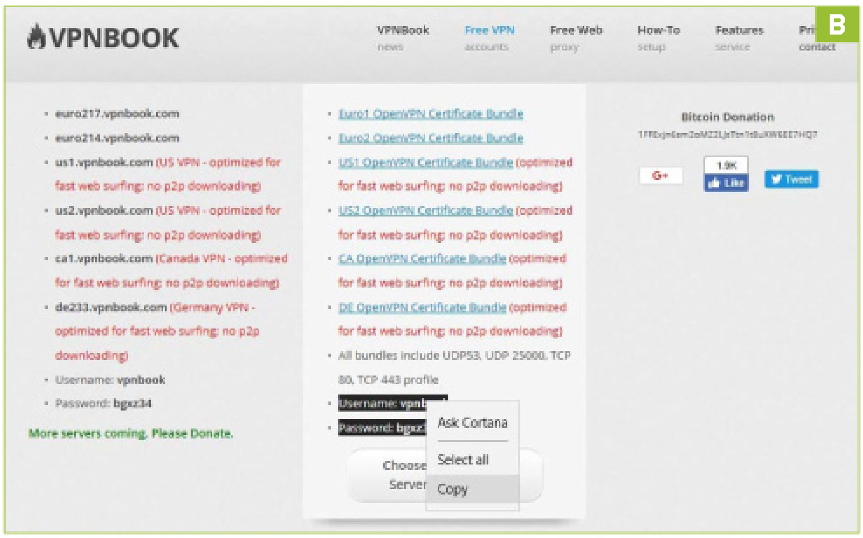

C
openvpn.net/index.php/open-source/downloads.html
HOWTO
Security Overview
Examples
Graphical User Interface
Manuals
Change Log
Installation Notes
Release Notes
Miscellaneous
Non-English
File Signatures
Articles
FAQ
General
Client
Server
Books
Wiki/Tracker
Forums
Contributing

Compared to OpenVPN 2.3 this is a major update with a large number of new features, improvements and fixes. Some of the major features are AEAD (GCM) cipher and Elliptic Curve DH key exchange support, improved IPv4/IPv6 dual stack support and more seamless connection migration when client's IP address changes (Peer-ID). Also, the new --tls-crypt feature can be used to increase users' connection privacy.

A summary of the changes is available in Changes.rst, and a full list of changes is available here.

OpenVPN GUI bundled with the Windows installer has a large number of new features compared to the one bundled with OpenVPN 2.3. One of major features is the ability to run OpenVPN GUI without administrator privileges. For full details, see the changelog. The new OpenVPN GUI features are documented here.

Please note that OpenVPN 2.4 installers will not work on Windows XP.

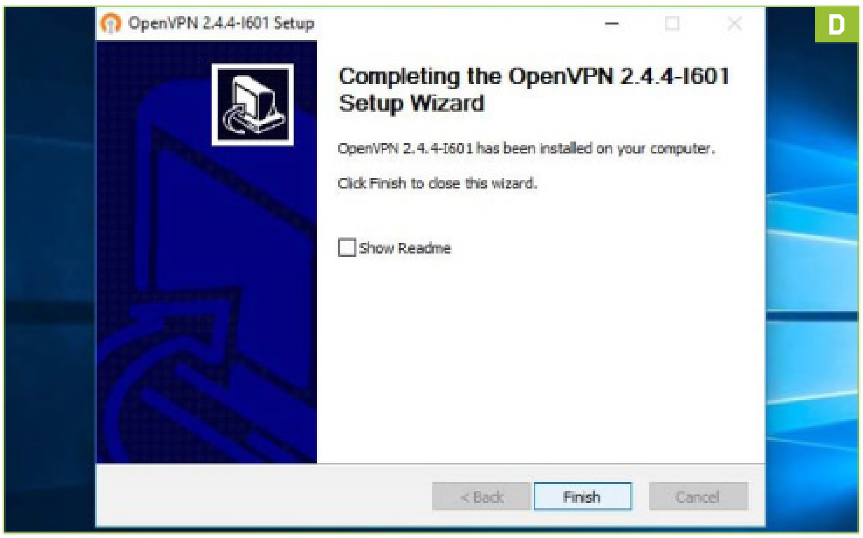

B
VPNBOOK
VPNBook news
Free VPN accounts
Free Web proxy
How-To setup
Features service
Pri contact
G+
1.9K
Like
Tweet
Ask Cortana
Select all
Copy
Choose Server

- euro217.vpnbook.com
- euro214.vpnbook.com
- us1.vpnbook.com (US VPN - optimized for fast web surfing; no p2p downloading)
- us2.vpnbook.com (US VPN - optimized for fast web surfing; no p2p downloading)
- ca1.vpnbook.com (Canada VPN - optimized for fast web surfing; no p2p downloading)
- de233.vpnbook.com (Germany VPN - optimized for fast web surfing; no p2p downloading)
- Username: vpnbook
- Password: bgxz34

More servers coming. Please Donate.

- Euro1 OpenVPN Certificate Bundle
- Euro2 OpenVPN Certificate Bundle
- US1 OpenVPN Certificate Bundle (optimized for fast web surfing; no p2p downloading)
- US2 OpenVPN Certificate Bundle (optimized for fast web surfing; no p2p downloading)
- CA OpenVPN Certificate Bundle (optimized for fast web surfing; no p2p downloading)
- DE OpenVPN Certificate Bundle (optimized for fast web surfing; no p2p downloading)
- All bundles include UDP53, UDP 25000, TCP 80, TCP 443 profile
- Username: vpnb
- Password: bgxz

Bitcoin Donation


D
OpenVPN 2.4.4-I601 Setup
< Back
Finish
Cancel

Completing the OpenVPN 2.4.4-I601 Setup Wizard

OpenVPN 2.4.4-I601 has been installed on your computer.

Click Finish to close this wizard.

☐ Show Readme

4 DOWNLOAD OPENVPN CLIENT

Point your web browser at https://openvpn.net/index.php/open-source/downloads.html [Image C], and download the OpenVPN client. Scroll down and choose "Installer, Windows Vista and later." Run the program, and click "Yes" to allow changes to be made to your PC, if necessary. Minimize your web browser for now, and the OpenVPN installer setup will appear. Click "Next" to continue.

5 INSTALL THE OPENVPN CLIENT

Read through the OpenVPN Client License Agreement, and click "I Agree" once you've understood the terms and conditions. On the "Choose Components" screen, leave the default options checked. Click "Next," then confirm the install location. You'll see a confirmation regarding the TAP-Windows provider. Click "Install" to continue. Once setup is complete, click "Next," then "Finish" [Image D].

6 ADD CONFIGURATION FILE(S)

You'll now see a shortcut to the OpenVPN client on your desktop. Leave this for now, and open File Explorer. Navigate to the new config folder OpenVPN has created in your account (C:\Users\<username>\OpenVPN\Config), then copy and paste the configuration (OVPN) file or files you downloaded from your provider [Image E]. Close File Explorer when done.

7 LAUNCH THE OPENVPN CLIENT

Double-click the OpenVPN shortcut on your desktop. The client icon will appear in the Taskbar. The first time you run the client, you're asked for the username and password for your chosen OpenVPN service. Make sure "Save Password" is checked, and click "OK"[Image F]. Windows 10 displays a notification once you're connected. The OpenVPN icon in the Taskbar also turns green.

8 CHECK YOUR IP ADDRESS

You can double-check your connection by viewing your public IP address as far as the web is concerned. Open your web browser, and navigate to www.whatismyip.com. This not only displays your IP address, but also your apparent location. If you expected to appear in a different country, you may have downloaded the wrong OVPN configuration file.

9 CHECK FOR DNS LEAKS

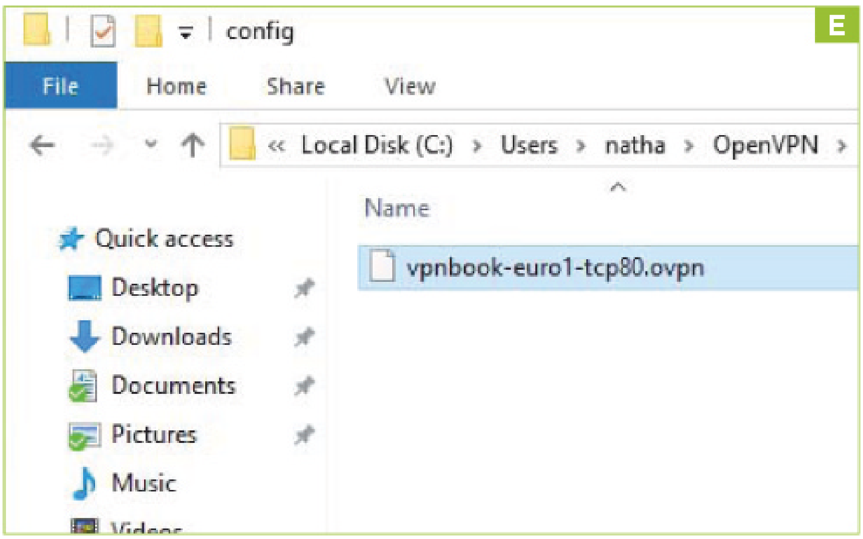
Depending on your VPN provider, you may find your DNS (Domain Name Server) requests are still being leaked. This means it may be possible for your ISP to track which websites you visit, even if you're using a VPN. To check this, visit www.dnsleaktest.com while connected via OpenVPN, and click "Extended Test." If your true location appears, your browsing history may be visible [Image G].

10 FIX DNS LEAKS

If you find that your DNS requests are being leaked, right-click the OpenVPN icon at the bottom of your screen, and disconnect. Navigate to your configuration file, and double-click to open it in Notepad. Add the line "block-outside-dns" to the attributes listed above "<ca>" [Image H]. Save and exit. From now on, you'll be using your VPN provider's DNS servers. ⏻

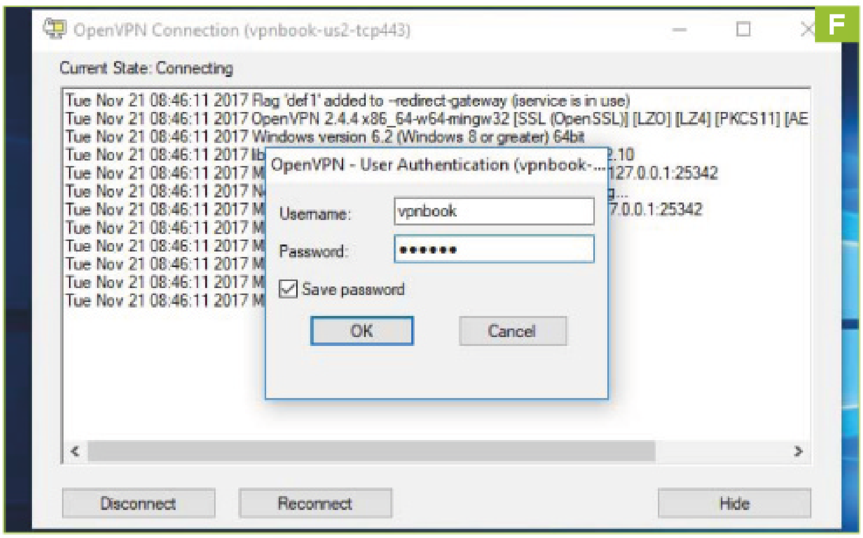
SETTINGS STORAGE

Your OpenVPN settings are stored in .ovpn or .conf files. You can download them from your VPN provider.


E

config
File
Home
Share
View
« Local Disk (C:) › Users › natha › OpenVPN ›
Name
Quick access
Desktop
Downloads
Documents
Pictures
Music
Videos

vpnbook-euro1-tcp80.ovpn


F

OpenVPN Connection (vpnbook-us2-tcp443)

Current State: Connecting

```
Tue Nov 21 08:46:11 2017 Flag 'def1' added to --redirect-gateway (iservice is in use)
Tue Nov 21 08:46:11 2017 OpenVPN 2.4.4 x86_64-w64-mingw32 [SSL (OpenSSL)] [LZO] [LZ4] [PKCS11] [AE
Tue Nov 21 08:46:11 2017 Windows version 6.2 (Windows 8 or greater) 64bit
Tue Nov 21 08:46:11 2017 lib                                    2.10
Tue Nov 21 08:46:11 2017 M                                      127.0.0.1:25342
Tue Nov 21 08:46:11 2017 N                                      g...
Tue Nov 21 08:46:11 2017 M                                      7.0.0.1:25342
Tue Nov 21 08:46:11 2017 M
Tue Nov 21 08:46:11 2017 M
Tue Nov 21 08:46:11 2017 M
Tue Nov 21 08:46:11 2017 M
Tue Nov 21 08:46:11 2017 M
```

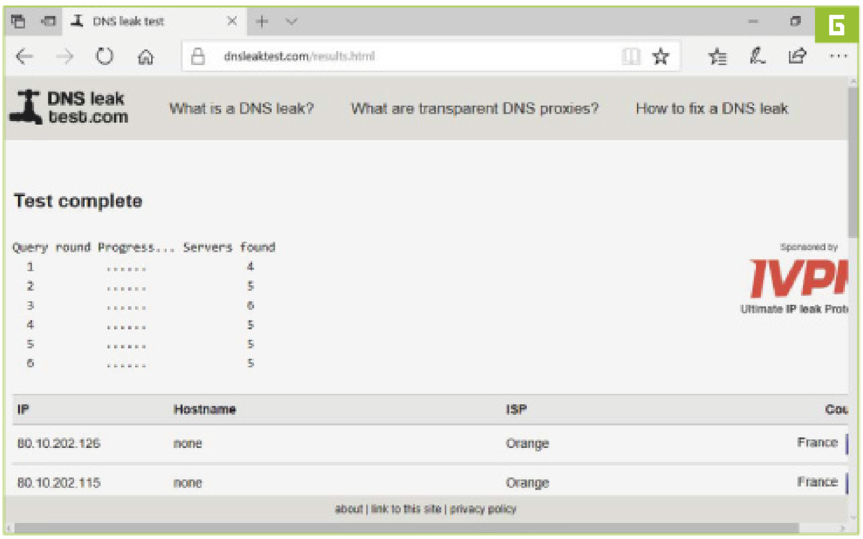
OpenVPN - User Authentication (vpnbook-...

Username: vpnbook

Password: ••••••

☑ Save password

OK
Cancel
Disconnect
Reconnect
Hide

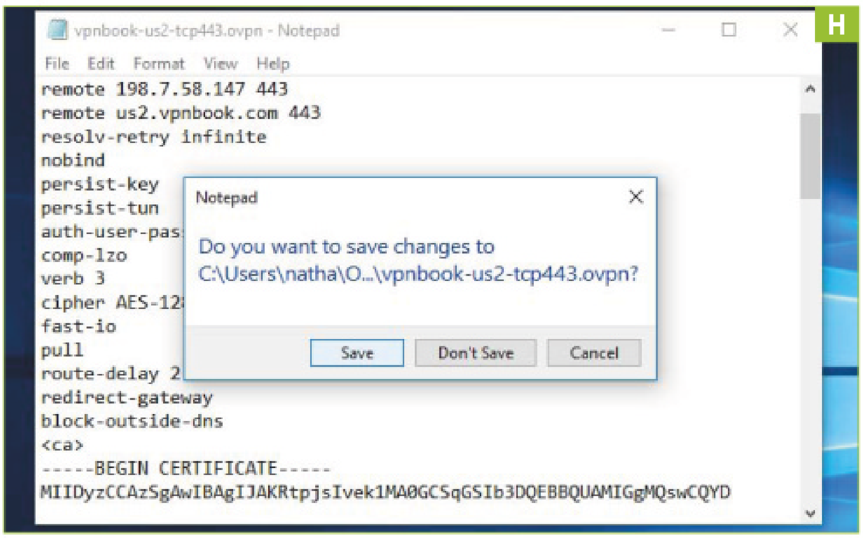

G

DNS leak test
dnsleaktest.com/results.html
DNS leak test.com
What is a DNS leak?
What are transparent DNS proxies?
How to fix a DNS leak
Sponsored by
IVPI
Ultimate IP leak Prot
about | link to this site | privacy policy

Test complete

```
Query round Progress... Servers found
  1          ......          4
  2          ......          5
  3          ......          6
  4          ......          5
  5          ......          5
  6          ......          5
```

IP	Hostname	ISP	Cou
80.10.202.126	none	Orange	France
80.10.202.115	none	Orange	France


H

vpnbook-us2-tcp443.ovpn - Notepad
File
Edit
Format
View
Help

```
remote 198.7.58.147 443
remote us2.vpnbook.com 443
resolv-retry infinite
nobind
persist-key
persist-tun
auth-user-pas
comp-lzo
verb 3
cipher AES-12
fast-io
pull
route-delay 2
redirect-gateway
block-outside-dns
<ca>
-----BEGIN CERTIFICATE-----
MIIDyzCCAzSgAwIBAgIJAKRtpjsIvek1MA0GCSqGSIb3DQEBBQUAMIGgMQswCQYD
```

Notepad

Do you want to save changes to C:\Users\natha\O...\vpnbook-us2-tcp443.ovpn?

Save
Don't Save
Cancel

BUILD IT

ZAK STOREY, CONTRIBUTING EDITOR

A Trip Down 2080 Lane

A special request for an RTX 2080 system to star in a commercial video shoot

LENGTH OF TIME: **1-2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

ANOTHER MONTH, another request from some department or another within *Maximum PC's* parent company. Our publishing house is a big business, and a lot of us work across multiple platforms and multiple brands, either helping each other out just because we can (we flattened two Xbox hard drives today for the IT team, for example), or on a freelance basis, kinda like what this Tom's Hardware journalist is doing here today.

This time, however, the request came from the video production guys. These folk do some really good work in the more "commercialized" area of the business, filming ads and pitching creative ideas to a whole plethora of big-buck names across the world. They've requested help from us in the past, and lo and behold, here we are again, with another system build for them.

The brief was simple: Build a system featuring an Nvidia RTX 2080 that the video team could use to showcase some world-exclusive gameplay, aka *Metro Exodus,* running on that wee ray-tracing beastie from the generation Nvidia likes to call current. There wasn't a whole lot of instruction on how or what to build, only that the case would need to have a transparent side panel (no, duh, thanks guys!), and feature some RGB lighting/fans, because the visuals were very important to the piece, or so we were told.

So, we cracked out the contacts book, and with the hardware we already had, reached out to Asus and Nvidia, and set to work.

PHANTEKS
RM

FILM-SET READY

WE KNOW IT SOUNDS like a rather glamorous affair, but it's not really that unusual for us to receive requests like this. After all, there are very few people in the company who know as much about system building as we do. Because of that, it means we typically know what they're after, more so than they do, even with such a limited brief. For instance, here we also thought it might be used for capturing video, so had video editing in mind from the start.

We also knew that we needed a card that was obviously an RTX 2080, so any AIB partner or aftermarket GPU was off the table. Annoyingly, Jarred being a wily home-worker, and currently having in his possession the only RTX 2080 *Maximum PC* had at the time, we had to request in a second Founders Edition from Nvidia for the job, because he was out of town.

Once that was done, the next step was "RGBing" it up. Asus was our first port of call—we reached out to the team there, and they provided us with the motherboard, screen, peripherals, and, naturally, the Asus ROG Aura Terminal kit, which comes with two addressable LED lighting strips that we can stick here, there, and everywhere.

We also threw in a Core i9-9900K (because, gaming), an Asus ROG Ryujin 360mm cooler, complete with Noctua NF-F12 Chromax fans, and 32GB (4x 8GB) of HyperX Predator RGB to sate the video team's desire for that frustrating frippery the industry seems so taken with. Then, rather foolishly, we slapped an OS-already-installed Samsung 960 Evo 500GB PCIe SSD in the thing, one that we may have pinched from that traitorous erstwhile deputy editor's machine. (Fun fact: It was previously an AMD build, so chipset conflicts galore!) Anyway, on to the build....

INGREDIENTS

PART		STREET PRICE
Case	Phanteks Eclipse P600S	**$150**
Motherboard	Asus ROG Strix Z390-E Gaming	**$236**
CPU	Intel Core i9-9900K	**$526**
CPU Cooler	Asus Ryujin 360	**$280**
GPU	Nvidia GeForce RTX 2080 Founders Edition	**$800**
Memory	32GB (4x 8GB) Kingston HyperX Predator RGB @ 2,933MT/s	**$319**
PSU	750W Corsair RM750x White	**$150**
Storage 1	500GB Samsung 960 Evo	**$140**
Storage 2	N/A	**$0**
Operating System	Windows 10 Home 64-bit	**$100**
Total		**$2,701**

1

AIR FILTRATION

MMM, ANOTHER PHANTEKS CASE, another intuitive design feature. Welcome, ladies and gents, to the removable roof and front panels. These two beauties come lined with sound-dampening material as standard, and stay in position via the power of magnets and notches, top and front. If you're after a quiet system, keep the panels in place, and the fans will still draw air in from the side, top, and back vents. Need a little more cooling during those hot summers? Then remove them both, allowing the fabric mesh and filter-covered fans to make the most of that lovely fresh air.

2

HADOOOUKEN

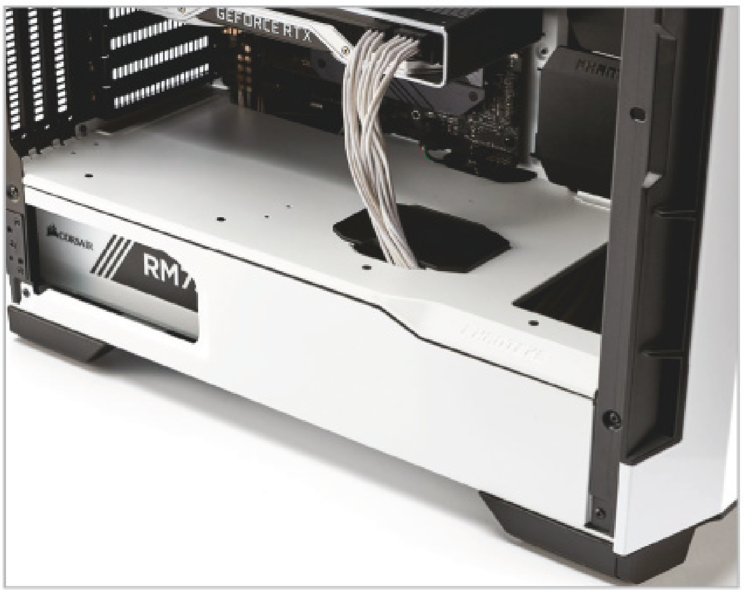
EVERY TIME WE SEE THE WORD "Ryujin," that's where our mind goes. However, this all-in-one liquid cooler is a little more complicated than first meets the eye. It looks slick and clean, for sure, but underneath that magnetically attached two-way mirror lies a deceptively annoying CPU block. In short, you can only mount it to the motherboard one way, with the tubing to the right. If you don't, your cover (and subsequent OLED display hidden underneath) will be at the wrong angle, and there's no way of either flipping the screen display or rotating the magnetic clip-on cover.

GEFORCE RTX

3

RG... NOPE

SHE MAY HAVE THE SAME INNARDS, but the Eclipse P600S definitely isn't the Evolv X, and underneath this sultry PSU cover, there is no bank of RGB LEDs ready to illuminate the inside of the case. There's a certain irony to that, really, given the brief, but we actually think the Eclipse P600S looks good enough without it. Couple that with the clean black line going across in the white model, in conjunction with our favorite white PSU from Corsair, and it all comes together quite nicely. If only we'd had enough time to request in one of those sexy vertical GPU brackets....



4

REAR I/O PLATES FOR DAYS

NOTHING SAYS "SATISFYING" quite like a built-in rear I/O plate. You know, if this isn't a new standard going forward across the majority of premium chipset motherboards, we're not interested. Seriously, it's just so nice not to need to remember it—simply line up your motherboard, secure it down, and watch as the plate slots safely into the back, with no harm and no foul. One thing we did wish is that there were a few more USB ports on the back of this, but aside from that, the Strix Z390-E is a fairly solid board. Also, from this angle, you can see the included space up top for an additional ITX system, if you so desire—maybe one for the significant other? A couple who plays together stays together? No, wait, that sounds wrong.

5

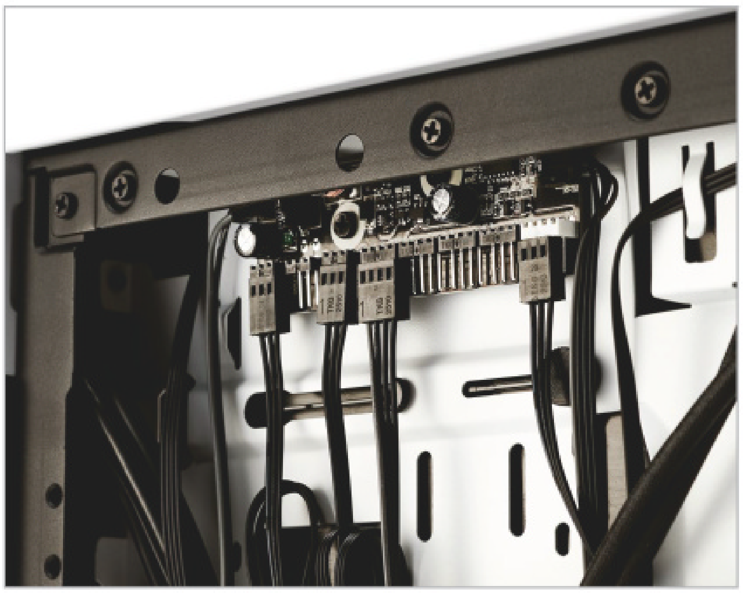
LED COMMAND UNITS

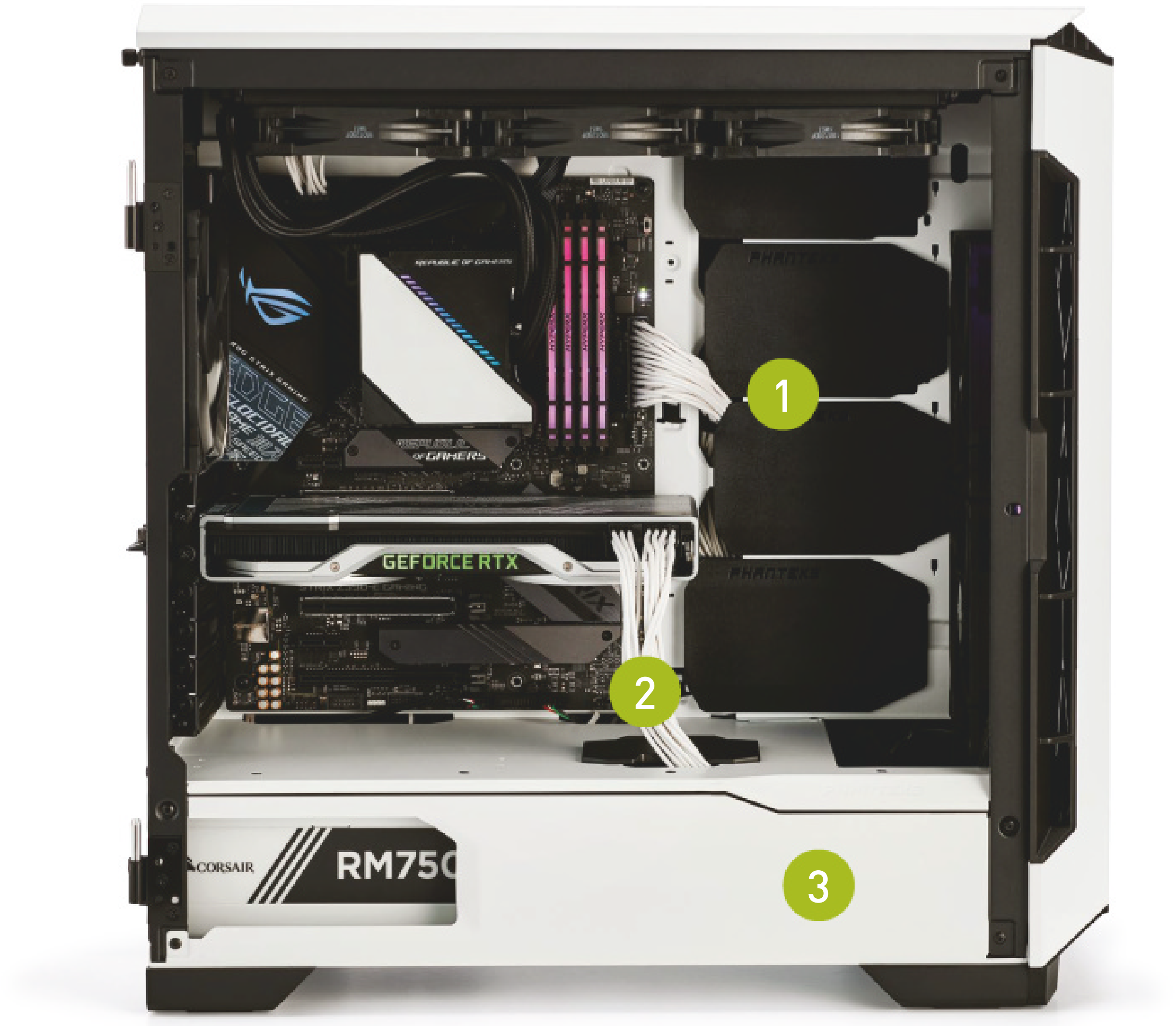
"WHERE IS THE HORSE AND THE RIDER? Where is the horn that was blowing? They have passed like rain on the mountains. Like wind in the meadow. The days have gone down in the West. Behind the hills, into shadow. How did it come to this?" We feel that's an apt enough quote to place here. But seriously, here we have Asus's RGB Aura Sync unit, a nifty little device into which you can plug multiple RGB LED things, so you can RGB your RGB more, or something. Oh, and run up your electricity bill, too. That said, it does work rather well, annoyingly.

6

OUR BIGGEST FANS

NOW, THIS IS SOMETHING we can get behind: integrated fan controllers. Here we can spy a somewhat primitive but exceptional piece of hardware, Phanteks's own integrated fan controller. It supports up to seven fans in total, PWM or standard three-pin, is powered by a SATA header, and plugs in directly to a PWM port on the motherboard, regulating all of the case fans to a single speed. Although not quite as sophisticated as some other fan-controlling options, it's nonetheless a nice feature to have on a chassis at this price point, and one that works well. No fuss, just plug and play.





① Phanteks's sliding cable covers work well here (better than cable grommets), and are easy to configure. However, they can be tricky if you suffer from OCD.

② Our Corsair RM750X is getting a little dated now, and the cable's a bit grubby—a burden with an overly used white power supply.

③ This case is exceptionally roomy. There are up to four 3.5-inch hard drive mounting points down under the PSU cover, and a further three 2.5-inch hard drive mounting points on the rear of the mobo tray.

THE BEST-LAID PLANS OF MICE AND MEN

THERE YOU HAVE IT FOLKS: a clean, crisp, RGB-equipped build. What you didn't see was the effort we went to getting in a few extra bits and pieces for the shoot. We had a week to get the parts in, build it, and get it ready for filming, which we managed, including peripherals, and a huge 34-inch screen. So, did it all come together? No. The video team reached out to the client with their pitch, and they did a U-turn on the decision to run the article. Which sucks, especially when all that work goes to waste.

That said, it did give us the opportunity to take a look at a few new pieces. Building a relatively budget rig—well, budget for an RTX 2080 build—was insightful on a performance basis. Plus, building in the Eclipse P600S wasn't due to be on our agenda for some time, so it also gave us the chance to take a good look at the chassis.

And, boy, what a chassis. It's beautiful to work with. Like most Phanteks cases, it's spacious, packed with a ton of accessories, and supports some seriously nifty features, which we have no doubt are going to make it into the next generation of cases from its competitors, too.

Is the build any good, though? Well, yeah. Once we'd got past the conflicting drivers and chipsets (full reinstall), it performed like a beast, and we got some solid numbers out of it. Say what you want about Nvidia's RTX lineup, but on a pure brute-force level, it performs exceptionally well. It's just a bit harder to stomach the price over last gen .

What would we change? The big one is the cooler—the OLED in the middle isn't exactly classy. The ones on Asus's motherboards are far sleeker, and the fact that this one just has a rotating ROG logo on it as standard felt a bit cheap, as did the majority of the unit. Coupled with the phenomenal price tag, it starts to sound like a bad deal.

We'd also probably change the PSU. Our Corsair RM750 is still working diligently, but it's getting old now, and those cables aren't quite as white as they once were, that's for sure.

On the whole, performance is impressive. At 1440p, the RTX 2080 decimates our zero-point in the gaming tests (although price-wise, it does sit between the 1440p and the 4K build perfectly). But with 119fps in *Rise of the Tomb Raider,* and 60fps-plus in everything else, perhaps it's time we retire the old GTX 1080 zero-point, and replace it with something a bit different? Well, the new guy can figure that out, and—spoiler alert—he's coming! ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	959	1,732 (81%)
CrystalDisk QD32 Sequential Read (MB/s)	3,422	2,687 (-21%)
CrystalDisk QD32 Sequential Write (MB/s)	1,706	1,745 (2%)
Rise of the Tomb Raider (fps)	95	119 (25%)
Total War: Warhammer II (fps)	55	73 (33%)
Tom Clancy's Ghost Recon Wildlands (fps)	48	59 (23%)
3DMark: Fire Strike (Index)	9,128	12,049 (32%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i5-8400, 16GB (2x 8GB) of Corsair Vengeance LPX @ 2,666MT/s, an MSI GeForce GTX 1080 Armor, and a 500GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1440p at the highest graphical profile.

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TESTED. REVIEWED. VERDICTIZED.

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NVIDIA

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TITAN RTX
NVIDIA

All hail the new king of consumer graphics cards!

Nvidia Titan RTX

A gold-plated status symbol for a godlike content-creation PC

AFTER LAST YEAR'S Titan V, we wondered what Nvidia could do to top it. Then the GeForce RTX 2080 Ti arrived, offering better performance and a bunch of new features, at a fraction of the price. "This will not do," shouted the gods of the old world. And thus was born the Titan RTX.

It was inevitable, though like the rest of the RTX line, Nvidia's pricing bespeaks an arrogance that comes from sitting unchallenged at the top for far too long. And that reign will undoubtedly continue, because AMD's Radeon VII (see page 78) isn't going to topple the RTX 2080, never mind the 2080 Ti and Titan RTX. But who actually needs this card?

For gaming, the answer is no one. At twice the price of the 2080 Ti, this is a classic tale of diminishing returns. Even at 1440p and 4K at ultra quality settings, the Titan RTX is only 5–10 percent faster at best; sometimes not even that. Turning on all the RTX-enabled enhancements doesn't really change things either—in *Metro Exodus* with ray-traced global illumination, or in *Battlefield V* with ray-traced reflections, we're still looking at a 5 percent advantage.

But if you simply must have the best prosumer graphics card on the market, the Titan RTX is packing the fully operational Turing TU102 GPU, with 4,608 CUDA cores, and 24GB of fast GDDR6 memory. It won't matter much in games—not in the card's lifetime at least, because they're all still built targeting 8–12GB VRAM use as a maximum—but for content creation, it might help. A bit.

Specs notwithstanding, the Titan RTX isn't quite a Quadro RTX 6000 alternative, thanks to the differing set of drivers. Nvidia boosted performance of the Titan cards with the previous generation Titan X/Xp/V when AMD unveiled its Vega Frontier Edition in 2017, and in most respects, the Titan RTX matches the Quadro RTX 6000 in SpecViewPerf 13. But the Quadro cards come with a different set of certified professional drivers, plus ECC memory support. The latter is for stability, while the former means some applications may still perform best on Quadro. Whether that warrants the price hike is for you to decide (or, more likely, your IT department), but for content-creation professionals, the Titan RTX can definitely hit a reasonable middle ground.

If you're just a regular consumer playing games, more than anything you're paying for bragging rights, and the status symbol of owning Nvidia's fastest and most exotic graphics card. Slap a couple of Titan RTX cards together with a high-end overclocked CPU, and you're heading straight for Dream Machine territory, which is what we found with the Falcon Northwest Mach V last month. But SLI support is becoming increasingly marginalized in games—including both of the current ray-tracing titles, which will only use a single GPU. Oops.

Our bigger concern is that, as with other Titan models, the Titan RTX's dubious reign is bound to be limited. You can get 95 percent of the Titan RTX performance with the far more affordable—yet still incredibly expensive—RTX 2080 Ti. When Nvidia's next-gen Ampere GPUs burst out of the company's collective skull in a year or so, probably cloaked in 7nm lithography and with even more new features and improved ray-tracing performance, the gold paint on the Titan RTX will start flaking away, exposing cracks in the once inspiring statue underneath.

If you want a year of bragging rights, that's your call, but keeping up with the bleeding edge can be painful. We suggest socking the savings away, and sticking with the non-Titan cards. Unless you're a prosumer, in which case we can legitimately make the argument that the $2,499 price is good value when compared with the $6,300 you'd pay for a Quadro RTX 6000. **–JARRED WALTON**

VERDICT
8

Nvidia Titan RTX

+ **DIVINE** Full TU102; tons of VRAM; prosumer features.

− **DEVIL** Extreme price; diminishing returns.

$2,499, www.nvidia.com

BENCHMARKS

	Titan RTX	RTX 2080 Ti	RTX 2080
Assassin's Creed Odyssey (Min/Avg fps)	**74/**51	**74/52**	60/41
Battlefield V (Min/Avg fps)	146/91	**147/92**	122/73
Deus Ex: Mankind Divided (Min/Avg fps)	**96/55**	93/53	74/41
Far Cry 5 (Min/Avg fps)	**135/80**	131/75	107/57
Forza Horizon 4 (Min/Avg fps)	**136/100**	131/94	118/81
Hitman 2 (Min/Avg fps)	**101/86**	**101**/80	99/64
Metro Exodus (Min/Avg fps)	**95/58**	90/56	71/43
Middle-Earth: Shadow of War (Min/Avg fps)	**125/77**	113/68	87/49
Strange Brigade (Min/Avg fps)	**172/98**	161/92	122/68
Total War: Warhammer II (Min/Avg fps)	**108/79**	107/74	96/56

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K overclocked to 5.0GHz in an MSI Z370 Gaming Pro Carbon AC motherboard, 16GB of G.Skill DDR4-3200 CL14, a 500GB Samsung 970 Evo M.2 SSD (OS), and a 4TB Samsung 860 Evo SSD (data/games). All games are tested at their highest graphical profile, with AA turned up, at 1440p and 4K.

SPECIFICATIONS

GPU	Turing TU102
Lithography	TSMC 12nm FinFET
Transistor Count	18.6 billion
CUDA Cores	4,608
Tensor Cores	576
RT Cores	72
ROPs	96
Texture Unit	288
Core/Boost Clock	1,350/1,770MHz
Memory Speed	14GT/s
Memory Capacity & Type	24GB GDDR6
Bus Width	384-bit
Memory Bandwidth	672GB/s
TDP	280W

A surprisingly affordable high-end rig.

MSI Trident X

You'll forget how it looks once you see it running

THERE'S A GROWING TREND for prebuilt small-form-factor gaming desktop PCs that come with a hefty specifications list. Small-form-factor cases have been around for a while, but the chassis of some of these new prebuilt PCs are nothing short of stunning, both on the outside and on the inside. Airflow becomes a higher priority with tightly spaced components, but the decent flow of air in MSI's Trident X isn't the only good thing about it.

At just five inches wide, the Trident X looks deceptively compact from the front, but just like a good pub sandwiched between old brick buildings, it extends three times as long, leaving enough room for a dual-fan RTX 2080 and everything else needed for a high-end gaming PC. The right side panel is swappable for either an opaque matt black metal panel or a dark frosted tempered glass alternative. The RGB heatsink fan is visible through the mesh vent on the side regardless, but that's the only pretty thing on that side of the case.

The rest of the visible internals are cables, the PSU, and two vertically mounted SSD bays. Not exactly exciting. Which is why some might prefer to leave the opaque panel on, but it's easier to access the SSD bays with a swinging, magnetic tempered glass panel. The other panel doesn't switch out, but there is also a mesh vent to show off the graphics card inside the case, which sits under the glow of RGB lighting, as well as a vent for the PSU fan.

Going back to the cooling solution, the Trident X model we received comes with an air-cooled Intel Core i9-9900K. Similar prebuilts generally come with an all-in-one liquid cooler, so how did this air cooling solution fair? The overclocked CPU on our model reached clock speeds of 4.8GHz at a high of 76 C when running multicore tests—well within a safe range.

Performance-wise, there isn't much left to the imagination, given the juicy list of high-end components. The processor consistently spat out numbers between 2016 and 2024 in Cinebench, and the 3DMark benchmarks showed crazy-good performance at 1080p and 1440p (23,709 and 12,459 respectively). 4K was a bit sluggish with a score of 6,494. Actual gaming in 1080p on ultra confirmed those 3DMark scores: *Shadow of the Tomb Raider* performed at an average of 122fps; *Total War: Warhammer II* at an average of 103fps between battle, campaign, and skaven modes; and *Ghost Recon: Wildlands* turned out an average of 74fps. At 1080p, *Metro Exodus* also performed at 60fps on ultra (ray tracing on), thanks to the RTX 2080.

The configuration we received was the top-of-the-line model Trident X, which retails for $2,499, but it also comes in two other configurations. The two lower models each come with an Intel Core i7-9700K, but the price only drops about $100 for the middle model, whereas it drops about $500 for the lowest. That lowest model comes with an RTX 2070, a 450W Bronze-rated PSU, and only a 512GB M.2 SSD (no HDD for extra storage), which all account for the bigger price drop. However, the price of the top-tier Trident X looks like a sweet deal for the specs if you compare it to other similar prebuilts on the market.

The MSI Trident X is not the prettiest small-form-factor PC out there, and some might balk at the air cooling solution and minimal RGB lighting, but for those looking for something that will handle nearly any game flawlessly up to 1440p on ultra, the Trident X has many excellent features. It's quiet and compact, and the price tag feels almost criminal, considering the components that inhabit the chassis. Another solid contender in the world of prebuilt, small-form-factor PCs. **–JOANNA NELIUS**

VERDICT
9

MSI Trident X

SPEAR Price; swappable side panel; slim chassis.

FORK Air-cooled processor; insides aren't much to look at.

$2,499, www.msi.com

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,152	2,026 (76%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	3,393 (-0.2%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	1,961 (14%)
3DMark: Fire Strike (Index)	11,101	23,709 (114%)
Rise of the Tomb Raider (fps)	60	122 (103%)
Total War: Warhammer II (fps)	46	103 (124%)
Tom Clancy's Ghost Recon: Wildlands (fps)	39	74 (90%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point consists of an AMD Ryzen 5 1600, 16GB of Crucial Ballistix Sport LT @ 2,666, an EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1080p at the highest graphical profile.

SPECIFICATIONS

Processor	Intel Core i9-9900K, with eight cores, 3.6GHz base clock, up to 5.0GHz boost
Graphics	Nvidia GeForce RTX 2080 Ventus 8GB overclocked
RAM	16GB DDR4 2,666MHz (1x 16GB)
Motherboard	Z370I Gaming Pro Carbon AC
Primary Storage	512GB PCIe NVME m.2 SSD
Additional Storage	2TB 5,400rpm HDD
Cooling Solution	Air cooling
PSU	650W 80 Plus Gold
Case	MSI Trident
Warranty	One year

It's AMD's fastest GPU, but is that enough to warrant the $700 price tag?

AMD Radeon VII

A promising first taste of 7nm, but not a revolution

RADEON VII IS THE FIRST GPU to be manufactured using 7nm lithography. On the face of it, that's a big jump from the previous 14nm technology. But the numbers used for a manufacturing process often contain a fair amount of marketing. In the Radeon VII's case, it's good progress, but it's not a transformation. And it's not enough to push the Radeon VII ahead of the competition, especially at a steep $700.

AMD doubled the number of HBM2 memory stacks, so you get 16GB and a whopping 1TB/s of memory bandwidth. The GPU core is much the same as the Vega 64, and with fewer GPU cores (3,840 compared to 4,096) and just a 200MHz improvement in clock speed, in theory it's only 6 percent more computational performance. However, AMD increased the number of integer and floating-point accumulators, and while it says these will help with compute performance, they could help in games as well.

One thing the Radeon VII doesn't do is add any major new features. For better or worse, Nvidia took a different approach last year with its GeForce RTX line, pushing ray-tracing hardware and deep-learning functions. Many complained and said, in effect, we wish Nvidia had used the die space on more GPU cores instead. AMD doesn't waste space on those forward-looking architectural changes, but neither does it add any cores.

What does that mean for games? With no dedicated hardware for ray tracing, performance in such workloads will likely be a fraction of the RTX line. But then, there's currently only three ray-tracing games, plus a couple of synthetic ray-tracing benchmarks. The Radeon VII can't even try to run any of those, as they appear to specifically target Nvidia's RTX GPUs. Peering into the hazy future with our crystal ball, there's a reasonable chance we won't get "acceptable" ray-tracing performance until the second generation of DXR hardware, so AMD playing the waiting game could pay off.

1440p ultra is arguably the best resolution for the Radeon VII, because 4K ultra at 60fps is still a bit of a stretch. Every game except *Odyssey* runs at more than 60fps, with the average sitting at nearly 100fps. Tweak a few settings, and smooth 60–144fps gaming is definitely within reach. In something of an ironic twist, AMD's talking point of Radeon plus FreeSync being better value than GeForce plus G-Sync is no longer as much of a factor, because Nvidia finally capitulated and has started to support adaptive refresh on FreeSync displays.

In terms of value, the Radeon VII is a bit of an odd one. This is the most expensive single-GPU solution AMD has ever released for the consumer market—it matches the price of the outgoing RX Vega 64 Liquid. Being more expensive doesn't inherently mean it's worse value, but the Radeon VII is in a bit of a tough spot. It's up to 35 percent faster than the RX Vega 64, and it's the fastest AMD GPU currently available, but it also costs 75 percent more than a Vega 64. In that sense, it's like the RX 590 launch: faster and better than the preceding cards as far as performance goes, but of worse value once you factor in price.

Despite taking different paths, it feels like AMD has ended up in the same place as Nvidia. The fervor of the crypto miners may have died down, but they've left a legacy of painfully high GPU prices. A price drop would go a long way toward rectifying things, but whether or when that might happen is anyone's guess. With 16GB HBM2, this isn't a cheap card to manufacture. Unless you must have the fastest AMD graphics card available, this looks like a good generation of GPUs to skip. It's not that the Radeon VII is bad, but it's not enough of a jump in features or performance to warrant the cost of an upgrade. **–JARRED WALTON**

VERDICT
7

AMD Radeon VII

+ **SEVENTH HEAVEN** First 7nm GPU; good 1440p/4K performance; lots of VRAM and bandwidth.

− **RING OF HELL** Slower than RTX 2080; lacking in features; worse efficiency.

$699, www.amd.com

SPECIFICATIONS

GPU	Vega 20
Lithography	TSMC 7nm FinFET
Transistor Count	13.2 billion
Shader Cores	3,840
Texture Units	240
ROPs	64
Core/Boost Clock	1,400/1,750MHz
Memory Capacity & Type	16GB HBM2
Memory Speed	1,024GB/s
Memory Bus	4,096-bit
TDP	300W
Display Connectors	3x DisplayPort 1.4, 1x HDMI 2.0b

BENCHMARKS

	AMD Radeon VII	Nvidia GeForce RTX 2080
Assassin's Creed Origins (Avg fps)	65/44	**82/53**
Deus Ex: Mankind Divided (Avg fps)	73/39	**74/41**
Far Cry 5 (Avg fps)	105/**57**	**107/57**
Grand Theft Auto 5 (Avg fps)	66/38	**85/44**
Middle Earth: Shadow of War (Avg fps)	81/48	**87/49**
Rise of the Tomb Raider (Avg fps)	74/42	**90/49**
Total War: Warhammer II (Avg fps)	76/45	**96/56**

Best scores are in bold. Our test bed consists of an Intel Core i7-7800K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung 970 Evo M.2. All games are tested at their highest graphical profile with AA turned up, at 1440p and 4K.

Zotac Gaming GeForce RTX 2060 AMP

A mainstream RTX card that's affordable and still fast

A MAJOR COMPLAINT with Nvidia's first generation of GeForce RTX cards was that the base model started at $500. With the release of the RTX 2060, that entry price point has dropped to $350, although this card from Zotac costs slightly more, at $370. That's still a relatively high-end graphics card price, but the performance is at least on the same level as existing $370 GPUs, such as the GTX 1070 and GTX 1070 Ti, and AMD's RX Vega 56. And that's for existing games. Future ray-tracing games, and games that use DLSS, should run substantially faster on the RTX 2060.

So, what does $370 get you? Basically, everything that's in the $500 RTX 2070, just a bit less of each. There are 30 SMs instead of 36, and 6GB of GDDR6 instead of 8GB. To put that in perspective, the drop from the RTX 2070 to the RTX 2060 is more like the difference between the GTX 1070 Ti and GTX 1070, rather than the 1070 and 1060. That $370 also nets you support for real-time ray tracing and DLSS cleverness, and we're talking a comparable drop in silicon, too, with 30 ray-tracing cores and 240 tensor cores as opposed to the RTX 2070's 36 RT cores and 288 tensor cores.

The clock speeds are nominally off the pace, too, with a base clock of 1,365MHz and a boost of 1,680MHz. One thing to keep in mind is that Nvidia's published boost clocks are actually quite conservative. Instead of being the typical GPU clock you're likely to see, we've found the boost clock is more often the minimum speed you'll see. Most games we tested saw clock speeds well in excess of 1,800MHz, with 1,850MHz being typical.

Testing at 1080p has the RTX 2060 ahead of the 1070 Ti, with average frame rates above 144. A few games bring the overall ranking way up, and in general the 2060 and other high-end GPUs aren't even close to being taxed. Even at ultra quality settings, the rankings don't change much, although the Vega 64 and 1070 Ti now come in just ahead of the 2060 on average. It's still a solid 10–15 percent boost to performance compared to the GTX 1070, the card it's really replacing.

Move up to 1440p, and ultra settings are still easily viable in most games, though a few won't quite manage 60fps. Some minor settings tweaks should fix that, and a good G-Sync display—or one of a select few Adaptive Sync, aka FreeSync, displays—will do wonders for avoiding tearing and other anomalies. Overall, the RTX 2060 continues to trade blows with the 1070 Ti and RX Vega 64. This isn't a card for 4K gaming. You could probably run low to medium settings at 4K and get 60fps in most games, but that's not a trade-off we'd recommend.

The RTX 2060 is by far the easiest of the RTX lineup to recommend. It's not just the price, it's the fact that performance is still good. It typically matches the GTX 1070 Ti, and that's without DLSS and DXR. If (dare we say when?) those catch on, it will become an even better bargain. It's not a perfect graphics card, because we noticed that enabling DXR in *Battlefield V* caused a bigger hit to performance at 1440p and 4K than on other RTX models. That might be simply because prior to now, all of the RTX cards had at least 8GB VRAM, but we'll have to wait and see.

Is the RTX 2060 worth buying, and should you upgrade your current card? As usual, that depends. Moving from a 1070 to a 2060 would be pretty pointless, but upgrading from a 970 or lower would give a substantial boost to performance for a reasonable price. We still wish prices were a bit lower, though, as an Nvidia "60" GPU going for $370 feels a bit too much like the cryptocurrency-induced pricing of 2018. Let's hope street prices fall a bit closer to $300 on the basic models. If you've been holding on to an older GPU looking for a good time to upgrade, the RTX 2060 is the best upper mid-range card (or lower high-end card) we've seen since the 1070 Ti. –**JARRED WALTON**

BENCHMARKS

	Zotac Gaming GeForce RTX 2060 AM	Nvidia GeForce GTX 1070 Ti
Assassin's Creed Origins (Avg fps)	**81/63**	79/60
Deus Ex: Mankind Divided (Avg fps)	70/48	**71/50**
Far Cry 5 (Avg fps)	108/72	**110/78**
Grand Theft Auto 5 (Avg fps)	**86/61**	85/60
Middle Earth: Shadow of War (Avg fps)	**88/60**	82/57
Rise of the Tomb Raider (Avg fps)	**84**/58	**84/61**
Total War: Warhammer II (Avg fps)	94/69	**96/71**

Best scores are in bold. Our test bed consists of an Intel Core i7-7800K, 16GB of G.Skill DDR4-3200, a Gigabyte Z370 Aorus Gaming 7, and a 1TB Samsung 970 Evo M.2. All games are tested at their highest graphical profile with AA turned up, at 1080p and 1440p.

VERDICT

9

Zotac Gaming GeForce RTX 2060 AMP

+ BUDGET Good value; great for 1080p and 1440p gaming; beats GTX 1070.

− FUDGE IT Very few RTX games; tied with GTX 1070 Ti; generational pricing increase.

$370, www.zotac.com

SPECIFICATIONS

GPU	TU106
Lithography	TSMC 12nm FinFET
Transistor Count	10.8 billion
CUDA Cores	1,920
Texture Units	120
ROPs	64
Core/Boost Clock	1,365/1,680MHz
Memory Capacity & Type	6GB GDDR6
Memory Speed	14GT/s
Memory Bus	192-bit
TDP	160W
Display Connectors	2x DisplayPort, 1x HDMI, 1x USB Type C

The RTX 2060 offers good value
for great performance.

ROG STRIX GAMING
REPUBLIC OF GAMERS
JOIN THE REPUBLIC
STRIX Z390-E GAMING
ROG
THE CHOICE OF CHAMPIONS
STRIX
LGA1151

Speed, speed, speed, hybrid, words....

Asus ROG Strix Z390-E Gaming

When did motherboards get so expensive?

WHEN ASUS SAID it would send us one of its brand new ROG Strix Z390-E Gaming boards for a system build this issue, we knew we'd have to get the thing on a test bench and see what it's all about.

At $250, it's hardly the cheapest motherboard out there, but it certainly doesn't throw any punches when it comes to the aesthetics portion of mobo design language. From the Japanese engraved I/O cover, to the diagonal stylizations, to the crisp black look lining the thing, it sure is a head-turner. The words inscribed on it can be a bit hit and miss, though, depending on how mature you are—most signify speed in some way or another: Edge, Speed, Velocidad (speed in Spanish), Game on, Hybrid…. Hybrid what, exactly? It's all a bit odd, and reminds us of those kids' sneakers from the '90s with the word "Turbo" written on the side of them, which lit up when you walked in them.

Anyway, apart from the questionable "shroud cybertext," as Asus is calling it, the Z390-E is actually a seriously well-equipped motherboard at this price point. You get two PCIe x16 slots running direct to the CPU; one PCIe x16 slot running in x4 mode, oddly; three standard PCIe 3.0 x1 slots; support for six SATA 6Gb/s ports; two M.2 PCIe 3.0 ports (one located under the CPU, and the other below what used to be the southbridge); and a selection of RGB headers, two of the standard type and one addressable.

It's quite a combination, and it also packs some serious overclocking grunt, with support for memory up to 4,266MT/s. Neat. As far as motherboards go, it performs well, scoring 30.38fps in Tech ARP's x264 benchmark, and 1,359 points in Cinebench R15's Multi test. It's a little slower in Fry Render, but memory latency and CrystalDisk sequentials are still on point, with power draw idle and load also averaging more or less what we would expect.

Overclocking is a fairly mixed bag—although we did achieve that Asus staple of 1.22V into the CPU for 5GHz, it slacked a little when it came to maximum overclock, and we only managed 5.1GHz at 1.33V stable, which was a bit of a disappointment. This could be down to the fact that the board runs with a single eight-pin EPS.

And that's about all there is to this board. It's a little underwhelming; there's nothing here that really stands out from the rest of the Asus crowd, nor the rest of the industry, for that matter. It's simply "fine." Performance is strong, aesthetics are debatably good, and overall, that's about it. The ROG Strix Z390-E Gaming is just another mundane ATX motherboard.

The biggest problem we have with it is the question of price. Let's face it, even in this reviewer's short time writing for the magazine, we remember when the Strix series of mobos was around $150–160 at most, the Hero was a $200 board, the more premium solutions, the Formula and Apex, were pushing $320, and the Extreme, the king of overclocking and innovative features, hit up to $400. Now we're at a point where all of those price points have increased by near enough $100 across the board, and we're not quite sure why. These are still good products, but it's not like there's been any dramatic increase in research or development costs. There's no drop in transistor size anywhere on the board, everything is dictated by Intel, so why the price is still skyrocketing is beyond our capacity to understand.

All in all, the Z390-E Strix is a good board: It looks clean and it performs well. But the pricing, man—we just can't get past that. **–ZAK STOREY**

BENCHMARKS

	Asus ROG Strix Z390-E Gaming	Asus ROG Maximus XI Gene
Tech ARP's X264 (fps)	**30.38**	29.66
Cinebench R15 Multi (Index)	1,359	**1,389**
Fry Render (m:s)	2:29	**2:23**
AIDA64 Memory Latency (ns)	48	**47**
CrystalDisk QD32 Sequential Read (MB/s)	**551**	550
CrystalDisk QD32 Sequential Write (MB/s)	**502**	495
Power Draw Idle/Load (Watts)	47/315	**42/307**
Total War: Warhammer II (fps)	**56**	**56**
Lowest Voltage @ 5.0GHz (Volts)	**1.22**	**1.22**
Maximum OC Achieved (GHz @ V)	5.1 @ 1.33	**5.1 @ 1.32**

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of Corsair Dominator Platinum DDR4 @ 3,000MT/s, an Nvidia GeForce GTX 1080, and a 250GB Samsung 860 Evo SSD. *Total War: Warhammer II* was tested at 1440p, on the ultra preset.

VERDICT

7

Asus ROG Strix Z390-E Gaming

⊞ **STRIVE** Good performance; strong aesthetics; decent connectivity options.

⊟ **STRIFE** Poorly priced.

$250, www.asus.com

SPECIFICATIONS

Chipset/Socket	Z390/LGA1151
Form Factor	ATX
Memory Support	64GB @ 4,266MT/s
M.2/U.2 Support	2x M.2 PCIe x4
SATA Support	6x SATA 6Gb/s
Max PCIe Support	2x PCIe 3.0 x16 (x8x8)
Rear I/O	4x USB 3.0, 3x USB 3.1 Type A, 1x USB 3.1 Type C, HDMI, DisplayPort, PS/2 Combi Port, Intel Gigabit Ethernet, Wireless A/C, 5.1 audio out, optical out

Phanteks Eclipse P600S

Guts and glory

THE ECLIPSE P600S could be mistaken for a poor man's Evolv X, at least from the inside. Strip off the panels and reveal the interior, and you're left with an almost identical layout to that found within the company's prestigious $210 flagship. You do lose out on the flashy RGB LED strip burned into the side of the PSU compartment, and the smart cable tidy covers on the back are missing, too (although those aren't entirely necessary, given the opaque nature of the rear side panel), but that aside, the overall shell is the same.

That's no bad thing. We've spoken at length about how Phanteks likes to take advantage of these structurally sound chassis, mixed with a multitude of external shells, and although the Eclipse P600S is no different in that regard, it's nothing to be shunned.

This case is $50 cheaper than the Evolv X, but it's not just a boring budget version, that's for sure. The exterior panels have been redeveloped to allow for more substantial airflow. Yes, the internals and the mounting setups are the same—you can still fit two 360mm radiators in here, front and top, or if you're feeling really bold, a 420mm up front and a 280mm in the roof—however, the showstopper comes from how Phanteks has redeveloped those attaching external panels.

The company has taken the same design language found in the rest of the Eclipse series, and baked it into those sheets of steel in a far more intelligent way than we've seen before. Both the front panel and the roof have removable central inserts, held in place by magnets and a notch. You simply grab it, lean it forward, and gently remove each panel to reveal the brand new fabric mesh underneath. That's not to say the fans located top and bottom don't have access to good airflow—a quick glance at the filters on the side shows us there's more than plenty here. But for seriously hot months, or when the air conditioning breaks down, removing them this easily ensures your rig has as much access as possible.

It's impressive, to say the least, and it does make a huge difference. Being able to swap between silence and performance on the fly, depending on your fancy, is a big deal, especially on a case of this caliber and at this price point. We've only seen features like this on over-engineered mechanical variants until now.

So, she certainly holds her own in contrast to the Evolv X, but for the uninitiated, what else does the Eclipse P600S provide? Well, support for 10 3.5-inch drives, plus three 2.5-inch drives, as standard (the 2.5-inch bays and four of the 3.5-inch ones come with the case). You also get a beefy fan controller located up top, a whole slew of Velcro straps in the bottom, some ridiculously smart panel cutouts, or folds, in the back of the case, to allow for easy access to plug in those top cables, and a seriously good accessory kit, including Phanteks's new GPU anti-sag bracket, and the ever-useful toolbox. You can also get a kit to add a second ITX system in the top of the chassis, if you so desire, or a vertical GPU mount, so you can see those graphics card fans spinning right in front of you.

In practice, building in the Eclipse P600S was a breeze, as enjoyable as it always is with Phanteks cases. It's ridiculously roomy, and performs impeccably. Any criticisms? We're hard-pressed to find one; perhaps the white is a bit too shiny for our tastes. **–ZAK STOREY**

VERDICT
9
KICK ASS!

Phanteks Eclipse P600S

+ ALPHA Impeccable internal layout; not just a budget market grab; impressive price; versatile.

− ALPACA No downsides of note.

$160, www.phanteks.com

SPECIFICATIONS

Form Factor	Mid Tower
Motherboard Support	E-ATX, ATX, microATX, ITX
Colors Available	Anthracite gray, glacier white, satin black
Window Available	Yes
3.5-Inch Support	10 (4 included)
2.5-Inch Support	3 (3 included)
Radiator Support	420mm front, 280mm roof, 140mm rear
Fan Support	3x 140mm front, 3x 120mm roof, 1x 140mm rear
Dimensions	9.5 x 20.5 x 20.1 inches
Graphics Card Clearance	17.2 inches
CPU Tower Clearance	7.5 inches
Weight	29.8lb

Samsung 970 Evo Plus 1TB

The best just got better

STAYING AT THE TOP is often tougher than getting there. Maybe that's why Samsung is revising its mainstream 970 Evo M.2 SSD less than a year after it went on sale. Whatever, we give you the Samsung 970 Evo Plus, in all its 96-layer glory.

The latter quip refers to the single significant change Samsung has made for the Evo Plus: the jump from 64-layer NAND flash chips to its latest 96-layer memory. It's the first mainstream use of 96-layer NAND in a consumer drive, and actually the fifth generation of Samsung's 3D flash memory.

Elsewhere, little has changed. For this 1TB model, the new Plus sports the same Samsung Phoenix controller chip and an identical 1GB of LPDDR4 DRAM. The minimum provisioning of 6GB of the drive's triple-level flash memory for operation in faster SLC mode also remains the same. However, the maximum the drive will allocate for this higher speed but lower data density mode has been increased from 36GB to 42GB. Again, that's specific to this 1TB model. Models from 250GB up to 2TB are available, and the size of both the DRAM and SLC caches varies by drive capacity.

The first and most obvious benefit of that 96-layer NAND is increased data density. That should mean cheaper SSDs at the same capacity, or more storage for a similar price. As is often the case with new tech, however, the cost savings haven't quite kicked in with 96-layer NAND, just as QLC NAND didn't deliver much, if anything, of a step-change in GBs per dollar when it appeared. So, while the 1TB Plus is around $200 cheaper than the equivalent 1TB 970 Evo was at launch a little under a year ago, current pricing for old and new fall within a few dollars, with the new Plus available for $275 as we go to press, and the old Evo 1TB actually a little cheaper at $273.

However, capacity isn't the only issue. This new NAND memory upgrades the interface speed between the controller and NAND from 800Mb/s to 1,400Mb/s. At the same time, the voltage is reduced from 1.8V to 1.2V. For the record, 96-layer NAND from the likes of Intel, Micron, and SK Hynix is only good for a 1,200Mb/s interface, while Toshiba-SanDisk 96-layer NAND tops out at 800Mb/s. Samsung has also tweaked the read and write latency, reducing it to 50μs and 500μs respectively, or about 30 percent.

On paper, the impact begins with a small uptick in sequential reads, from 3,400MB/s to 3,500MB/s. The jump in SLC cache write performance is much more impressive, leaping up from 2,500MB/s to 3,300MB/s. The underlying write performance of the NAND memory takes a big step, too, from 1,200MB/s to 1,700MB/s. QD1 IOPS are likewise up by 20–30 percent. All while maintaining endurance at 600TB of writes. Nice.

Those, of course, are the claims. What do our test numbers look like? Our suite of SSD tests has migrated a little since the 970 Evo, so we can't make direct comparisons across the board, but the sequential numbers are certainly in line with the expectations set by Samsung's claims. Perhaps more tellingly, the Plus shaves a hefty 7 seconds off the 31 seconds the old Evo needed to complete our internal 30GB file copy test. It's seriously quick for a mainstream drive, this new Plus. Results in Anvil's 4K metrics are generally very good, with the QD4 performance for writes of well over 700MB/s looking particularly sharp. In fact, by some measures, this new Evo is quicker than its more expensive 970 Pro sibling, even if platform differences may account for some of the delta. But however you slice it, one of if not the best mainstream M.2 NVMe drive just got a fair bit better. **–JEREMY LAIRD**

VERDICT
9
KICK ASS

Samsung 970 Evo Plus 1TB

+ SIX OF THE BEST Super all-around performance for the same money as before.

− HALF A DOZEN Relatively limited technical changes; no more capacity for your cash.

$275, www.samsung.com

BENCHMARKS

	Samsung 970 Evo Plus 1TB	Intel 905p 1.5TB	Samsung 970 Pro 512GB
30GB Internal Copy (Seconds)	**24**	29	29
CrystalDisk 6 Sequential Read (MB/s)	**3,565**	2,632	2,788
CrystalDisk 6 Sequential Write (MB/s)	**3,342**	2,313	2,331
Anvil 4K QD 1 Read/Write (MB/s)	45/**151**	**131**/145	48/141
Anvil 4K QD 2 Read/Write (MB/s)	96/**299**	**245**/273	91/281
Anvil 4K QD 4 Read/Write (MB/s)	191/**735**	**468**/518	152/524

Best scores are in bold. Our test bench consists of an Intel Core i7-8700K, an Asus Maximus X Hero, an Nvidia GeForce GTX 1080, 16GB of Corsair Dominator Platinum DDR4, and a Samsung 850 Evo 250GB OS SSD.

SPECIFICATIONS

Capacity	1TB
Interface	M.2 4x PCIe
Control Protocol	NVMe
Controller	Samsung Phoenix
NAND Type	96-layer 3D TLC
Sequential Read & Write	3,500/3,300MB/s
Read/Write IOPS	600/400K
Warranty	Five years

BenQ PD2700U

Give us pixels, and plenty of 'em

ADAPTIVE SYNC, crazy high refresh rates, HDR visuals, and quantum dot technotrickery are all great, but what the heck happened to plain old high-quality pixels, and having a lot of 'em? No question, the monitor market is nothing if not innovative of late, but there's a danger of losing sight of what's important.

Enter BenQ's new PD2700U. It's conspicuously lacking in all of the above. It runs at just 60Hz. It doesn't support adaptive sync. There's no fancy local dimming with quantum dot enhancements. And that's just fine by us.

Strictly speaking, the PD2700U is HDR10 compliant. But that reflects its ability to process an HDR signal. Without local dimming and with a maximum brightness of just 350cdm^2, this isn't a true HDR monitor. So, what exactly does it have to offer?

Most notable is the 27-inch panel, a high-quality IPS item, packing a full 4K 3840x2160 pixel grid. Throw in some decent control electronics, and you have a recipe for a very pleasing computing experience. Partly, that's thanks to the combination of the 27-inch diagonal and the 4K native resolution. Do the math, and that works out to 163 pixels per inch.

Granted, that's not quite "Retina"-style pixel density, but it does make for nice fonts and razor-sharp image quality. The clarity of high-quality 4K video content is a sight to behold. Moreover, calibrate your expectations, and we doubt you'll be disappointed by the image quality of the PD2700U. It's not going to blow you out of your chair with insane levels of HDR-style brightness, or supercharge your gaming with 120Hz-plus refresh, but this is a very nicely judged monitor.

Speaking of calibration, the PD2700U comes professionally calibrated from the factory. No doubt that's why it performs so well with our test images. There's little to no evidence of compression in black or white scales, while gradients are perfectly smooth, the viewing angles are about as good as it gets, and the color balance is bang on from a subjective perspective. Again, the HDR functionality on offer is limited, thanks to the relatively low brightness and lack of local dimming, but it does allow for the processing of HDR content, ensures wide color space support—including 100 percent of Rec. 709—and adds a little extra punch to the visual performance, the latter aided by the 1,300:1 static contrast ratio.

As for gaming, the 60Hz refresh will be a limitation for some, ditto the 5ms response and lack of adaptive sync. However, the PD2700U is more than up to some general purpose gaming within its broader remit, which is tilted more toward productivity and content creation.

Another highlight is the industrial design and build quality. The BenQ PD2700U is an understated operator, with monotone black plastics and low-key branding, but the build feels robust, and the slim bezels on three sides ensure a contemporary feel. The stand is also sturdy, with a full range of adjustment.

If there's an obvious omission, it's the lack of USB Type-C connectivity, such a neat solution for laptop owners—a single cable for power, display, and peripherals. There's some mitigation in the fact that BenQ has equipped the PD2700U with an integrated keyboard video mouse (KVM) switch and multi-stream transport for supporting daisy-chaining multiple monitors, and USB Type-C is more of a concern for laptop rather than desktop users, but here in 2019, no USB Type-C is a little disappointing. **–JEREMY LAIRD**

VERDICT
8

BenQ PD2700U

+ COLLEGE GRADUATE High-quality IPS panel; plenty of pixels; quality design and build.

− ELEMENTARY ERROR Short on snazzy features; no USB-C; not exactly cheap.

$535, www.benq.com

SPECIFICATIONS

Panel Size	27-inch
Native Resolution	3840x2160
Pixel Density	163 ppi
Panel Type	IPS
Maximum Refresh	60Hz
Response	5ms
Contrast	1,300:1
Display Inputs	HDMI, DisplayPort, Mini DisplayPort
Connectivity	USB 3.0
VESA Mount	100 x 100mm
Warranty	Three years

BenQ
New Sun Hong Kong Restaurant
新 香 港
RIGHT TURN ONLY
THALIA
GRANT
SYSCO
HOTEL

It might be 4K, but BenQ's PD2700U is an old-school operator.

Razer Atheris

It's Stuart Little all over again

ON THE OPPOSITE PAGE, we look at the portable Cooler Master SK650. That is a keyboard, this is a mouse, but they both bring up an interesting argument: How much room really is there in your bag? It doesn't matter how many accessories, documents, laptops, and cables you carry with you, unless you're attempting to stow your entire computing portfolio in a particularly tight fanny pack (and we'd advise against that strongly, for fashion reasons as much as practical ones), it's unlikely that you wouldn't have space somewhere for a full-size mouse. There are plenty of quality wireless game-friendly examples out there—Logitech's sleek G305, for one.

Granted, there is a valid argument for mice with smaller footprints, because shaving a couple of inches from the heel means said pointer becomes much more usable on smaller surfaces, such as tray tables. Beyond that, though, mini mice are usually an ergonomic nightmare. Not so much here: Razer's design for the Atheris, while not directly supportive of your palm, is curvy enough that it's comfortable for extended use, mainly because the company has not also skimped on the width. You may find yourself juggling it around with your fingers, rather than moving the heel of your palm, but that doesn't hurt its maneuverability. It's also supremely well balanced in terms of its weighting; for all intents and purposes, pushing the Atheris around your desk often feels very much like piloting a full-size mouse.

Its weight, which is somehow greater than most proper mice, is no doubt helped by the pair of AA batteries that give it juice for what Razer claims is up to 300 hours' constant use. Whether that waste, or the hassle of recharging your own AA cells, makes you wince, the convenience of being able to slap in a new set of batteries when your pointer seizes up can't be understated. Neither can the Atheris's flexibility—a three-position switch on the underside powers it off, and selects between a 2.4GHz wireless connection to the included USB dongle (stowable beneath the top shell when transporting) or Bluetooth. In theory, that means you can connect to a phone or tablet; in practice, while we were able to connect, we weren't actually able to make the Atheris do anything on our test Android device, so don't pick this up if that's your prime driver. It does, however, work with the Xbox One, as the majority of Razer's peripherals do.

SIDE EFFECTS

One thing it doesn't do is connect by a wire, but its frequency-jumping 2.4GHz connection is rock-solid stable, and plenty fast enough if what you're looking for is quick response, and it's likely you won't even notice any lag when running in Bluetooth mode. With a 7,200 dpi sensor, the resolution selector (located, as is the fashion, behind the scroll wheel) can make things rather crazy; all four buttons are fast and definite, with a weighty resistance on the face buttons, and a pleasing "tock" to the slim side pair. It is rare indeed that we like side buttons, but these work perfectly well.

There's no lighting to speak of, beyond a single LED in the DPI button occasionally used to indicate wireless connectivity; texture is limited to stippled embossing on the wheel, horizontal grooves on the silicon grips on either side, and a pretty standard unfinished plastic on the top shell. For Razer, this is about as outwardly understated a peripheral as you'll find, aggressive cutout groove at the front aside. Even the Razer logo is a subtle gloss on matt affair.

Contrary to our usually cautious standpoint on eye-assaulting peripheral design, we can't see the Atheris's cool shell shape as a selling point. Sure, this is very capable, and it fits its niche, and it's highly convenient, and it's well weighted. But it's not exciting, and it's not better than a big-boy mouse, even if you're really stuck for bag space. –ALEX COX

VERDICT 7

Razer Atheris

➕ **DINKY** Great weighting; excellent buttons; super sensor.

➖ **STINKY** Why go compact when you could have a proper mouse?

$50, http://razer.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	7,200 dpi
Sensor Model	Razer
Polling Rate	1,000Hz
Programmable Buttons	5
LEDs	One indicator
Cable Length	N/A

Cooler Master SK650

Portable power, problematic profile

HERE'S A HYPOTHETICAL QUESTION: What would happen if you took a desktop keyboard, and removed just about everything that made a desktop keyboard so awesome to use? Not that we're angry about it, or immediately accusing Cooler Master of doing such a thing, but let's review the evidence in descending order of glaringness. One: There's barely any angle to this ultra-compact keyboard, and no feet to adjust it. Two: CM has pulled in low-profile Cherry MX Red switches, rather than the full-height equivalent. Three, and this is probably the most egregious issue of all: The keycaps are basically flat, crammed together as though they're huddling for warmth.

OK, perhaps we are a little angry. But a keyboard shouldn't be a fight, and the SK650, though blessed with a heavyweight build and some amazing features, is a battle with every stroke. We've never hit backspace so much than when testing this; we found ourselves somehow more error-prone than when typing on a laptop keyboard, and presumably that, or the keyboards from some high-end gaming laptops, is what this was meant to emulate. If you're more used to portable typing, that might be something you're looking for, and we won't judge, but it does drop the SK650 into a very small niche indeed.

Thankfully, the switches are exactly as described. A low-profile version of Cherry's slightly bouncy, mid-actuating MX Red switches. And that's fine. They're not the most exciting switches in the world, there's no linear bump or click, and there's the most subtle spring noise while typing. The only real sound is the clatter of keycaps, and while these squares might hurt the feel of things for normal typists, they certainly do no harm to the SK650's acoustic properties. Perhaps a stiffer switch might work better with the closely clustered keys, but given Cherry's low-profile range consists of the 45cN Reds and, er, 45cN Speed Silvers (which actuate slightly higher), it's understandable that we're left with this.

GLOWING REPORT

What's slightly baffling is that even Cherry's low-profile switches are perfectly capable of accepting proper keycaps. On one hand, we'd like this board a lot more if it had dished caps with more space between keys on the top profile; basically, if it threw away its fundamental gimmick. On the other hand, that would definitely ruin its delicate lines, and that's something the SK650 has in spades. It's utterly captivating—a glowing full RGB art piece without a micron of wasted space around its beveled edges or between its stern, square keys. The reflective glow of the lighting, enhanced by the clear cases of each keyswitch, bleeds beautifully on to the matt metal of the brushed aluminum base. A translucent strip just below that base adds an extra subtle highlight—even the indicator LEDs are RGB colored, and react to the cycling and breathing color modes. For a portable keyboard, one that comes with a carrying bag in the box, that's some serious design.

In terms of other technology, it's similarly well appointed. Aside from the copious number of on-board lighting controls and media keys (a sometimes bewildering total of 26 keys have a Fn-based meta function), the cable connects via USB 3, a still-unusual feature. Run Cooler Master's software, and you can remap the keys, set up macros (including mouse clicks), and tweak that lighting more deeply. It's all very comprehensive. It's just such a shame that, for all its plus points, the SK650's basically unyielding form factor and its unreasonably flat keys are such a heavy detriment. Given that Cooler Master also produces the SK630—a tenkeyless version of the exact same keyboard—this doesn't even score that many portability points. It is undoubtedly well engineered and a joy to look at, and some typists might consider it the ultimate desk or bag upgrade. For us though? No. **–ALEX COX**

VERDICT
6

Cooler Master SK650

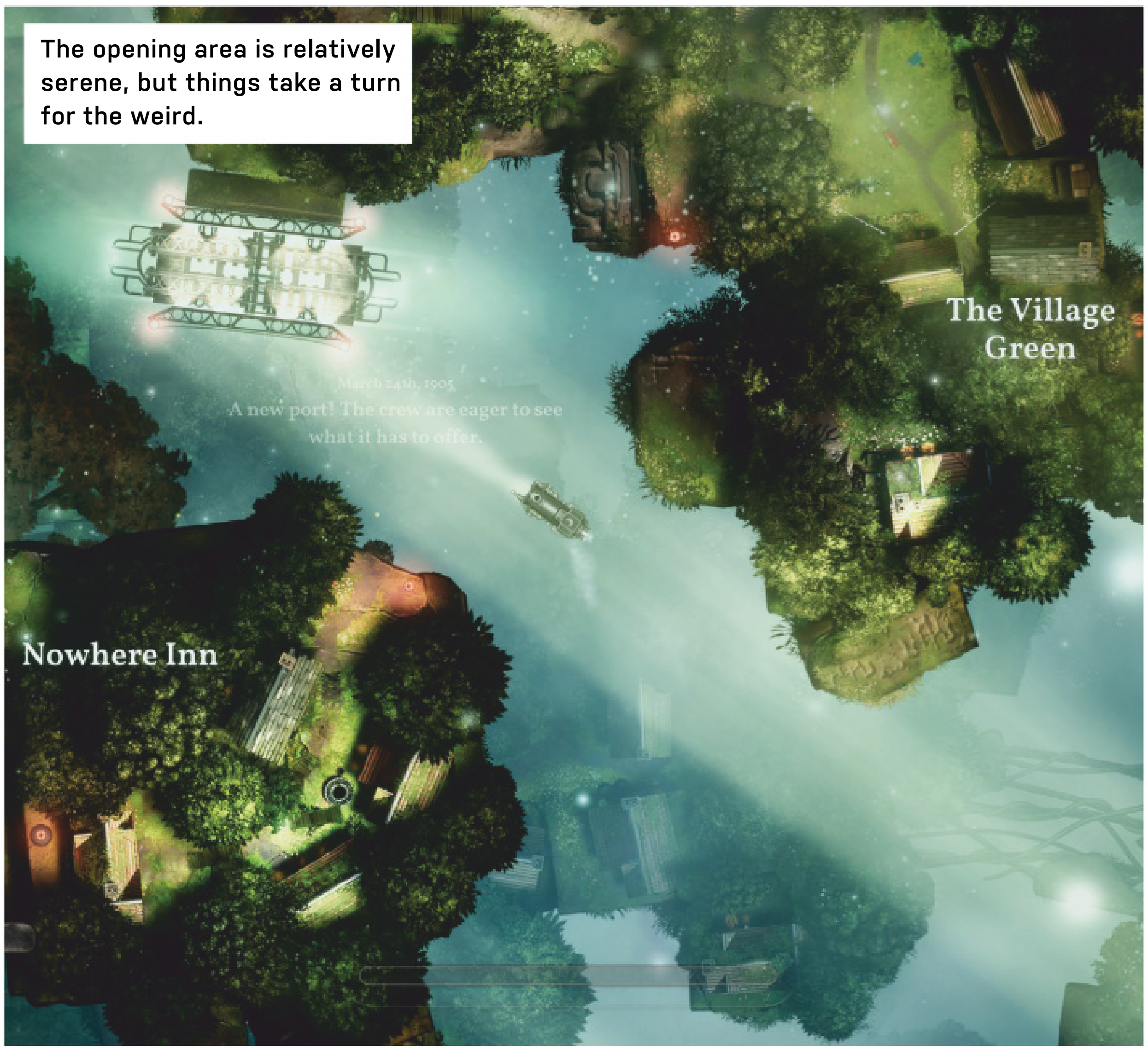
➕ **FIZZY** Gorgeous design; highly controllable RGB; portable.

➖ **FLAT** Inflexible; uncomfortable.

$119, www.coolermaster.com

SPECIFICATIONS

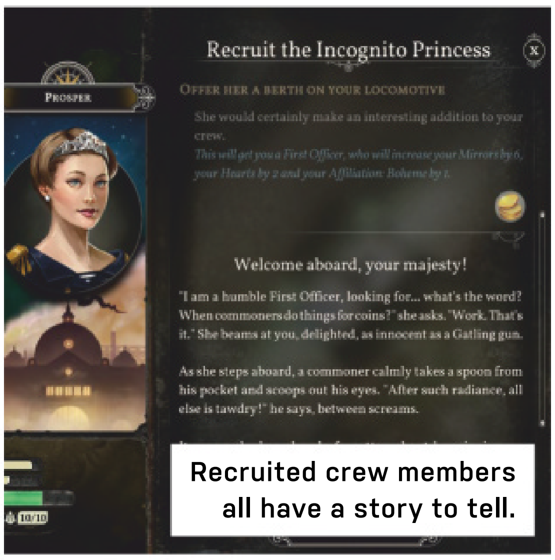
Switch Type	Cherry MX Red low profile
Form Factor	Full size
Media Keys	With Fn
Macro Keys	Customizable
LEDs	Full RGB
N-Key Rollover	N-key and 6-key
Pass-Through	No
Dimensions	13.9 x 4.9 x 1.2 inches
Warranty	Two years



The opening area is relatively serene, but things take a turn for the weird.

March 24th, 1905

A new port! The crew are eager to see what it has to offer.



Recruited crew members all have a story to tell.

Recruit the Incognito Princess

OFFER HER A BERTH ON YOUR LOCOMOTIVE

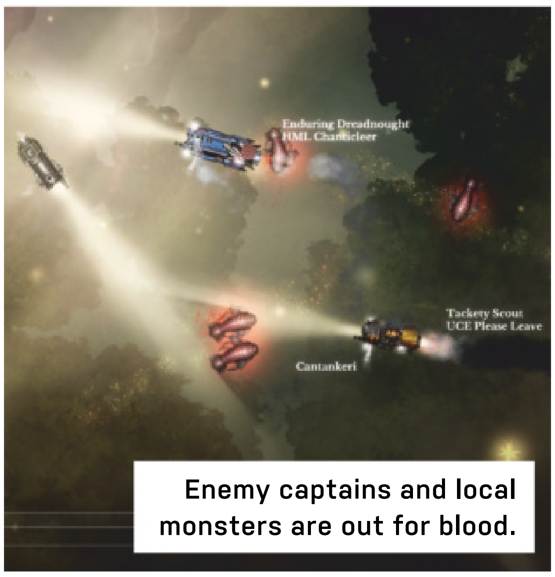
She would certainly make an interesting addition to your crew.

This will get you a First Officer, who will increase your Mirrors by 6, your Hearts by 2 and your Affiliation: Boheme by 1.

Welcome aboard, your majesty!

"I am a humble First Officer, looking for... what's the word? When commoners do things for coins?" she asks. "Work. That's it." She beams at you, delighted, as innocent as a Gatling gun.

As she steps aboard, a commoner calmly takes a spoon from his pocket and scoops out his eyes. "After such radiance, all else is tawdry!" he says, between screams.



Enemy captains and local monsters are out for blood.

Sunless Skies

We choo-choo-choose the nameless terrors of space

WE'VE DRIVEN SOME interesting vehicles while gaming, from stolen star-fighters belonging to a race of giant cats to an SUV that can drive up the side of a building. A space train, though? That's new.

Sunless Skies, from British indie dev Failbetter, builds on its previous releases, the browser-based RPG *Fallen London* and *Sunless Sea.* They're all set in the same universe, which sees the world destroyed after a cataclysm involving a bargain struck between Queen Victoria and a sentient shop (seriously), plus a swarm of bats. London sinks, and positions itself in a subterranean ocean.

Sunless Skies takes this gothic setting and applies it to space, your interplanetary train chuffing its way between chunks of what might have been our planet. It's not going to trouble your graphics card much, even though the screen is filled with 2D interest everywhere you go, but the real meat of the game is in the text.

And it's a flavorsome mouthful. Over and over again, the game serves up the imaginative and unexpected. The simple gaming loops are there—upgrade your loco, hire crew, go trading to make money, repeat—but it's the side missions at every port that pull you further in. You're dropped into the world with nothing but a sealed box and instructions to take it to a London address, but immediately get the chance to pick up a passenger and hear of a trade route that might be lucrative.

So, with a single cannon on your train, and just enough fuel and supplies, you steam off into the emptiness. Everywhere you stop, the writers have been there first. It comes close to interactive fiction in places. No port is quiet, and nowhere is dull. There's a kind of Lovecraftian horror at work as you hear reports of monsters in the ether, and as your crew's Terror score increases, and your captain begins to have nightmares, every trip into the unknown puts more at risk. Depending on a choice you make at the start, your captain's death may be permanent, passing control of the loco, and some of your knowledge and cargo, to your first officer in the event you succumb to the cold vacuum. Or you may just reload your last autosave, and try again.

Combat is a freewheeling battle of lining up shots, helped by your train's ability to strafe and turn. A clever difficulty setting affects how fast enemies shoot, and the way your shots arc into targets, but bad guys are tough, often inscrutable, and frequently lethal. As your crew descends into madness, and supplies run low many days out of port, the option of eating your train-mates may become more palatable than leaving them to a slow death in the high wilderness.

These kinds of highly literate games repay those long, late-night sessions when sleep just won't come, not by increasing your tiredness, but by giving you glimpses into worlds so terrifying and well realized, you might decide you never want to sleep at all. **–IAN EVENDEN**

VERDICT 9

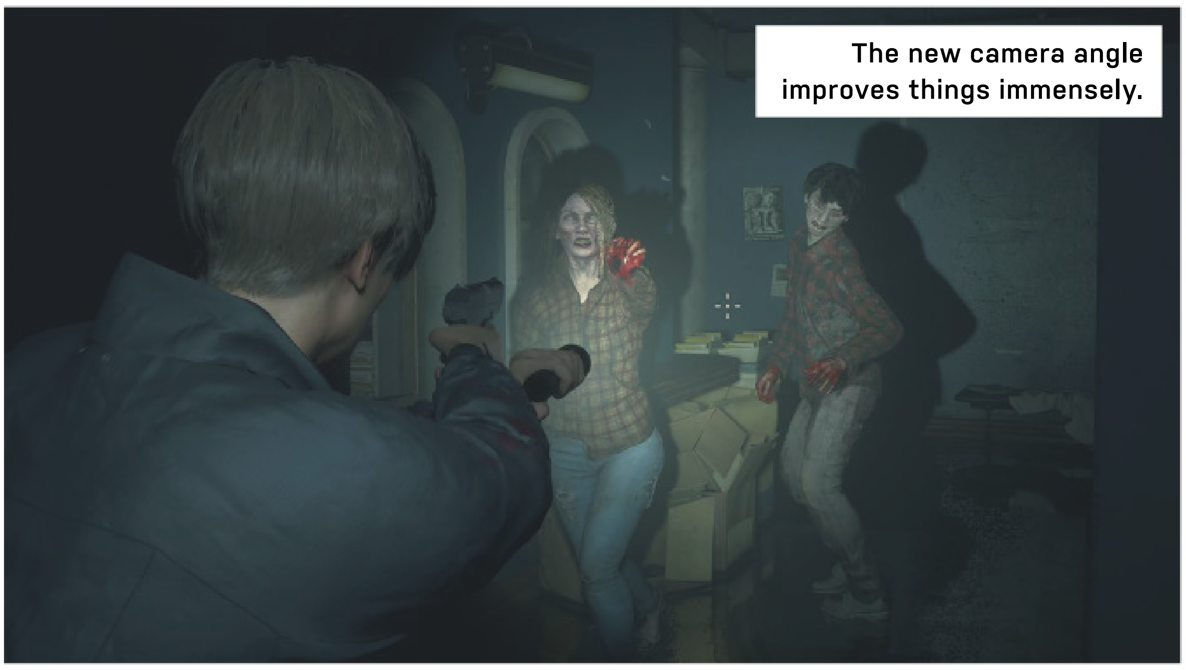
Sunless Skies

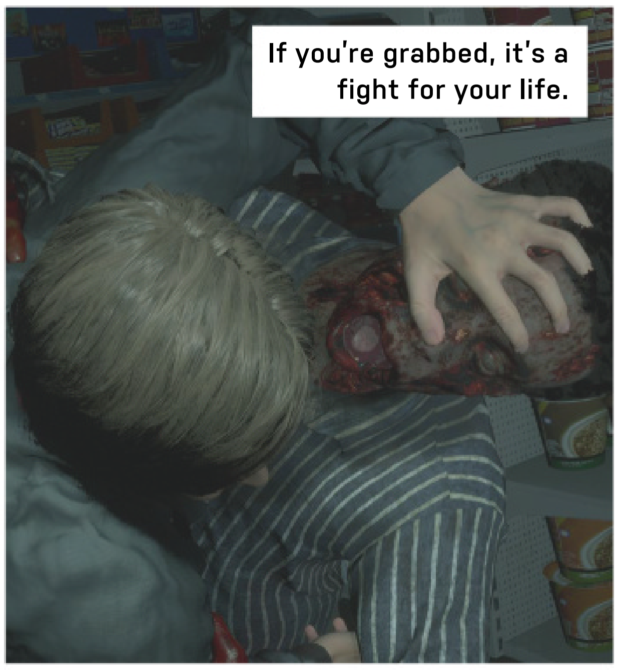
+ LOCOMOTIVE Excellent writing; thick gothic atmosphere.

– PSYCHOACTIVE Long journeys can take a while; death can come easily.

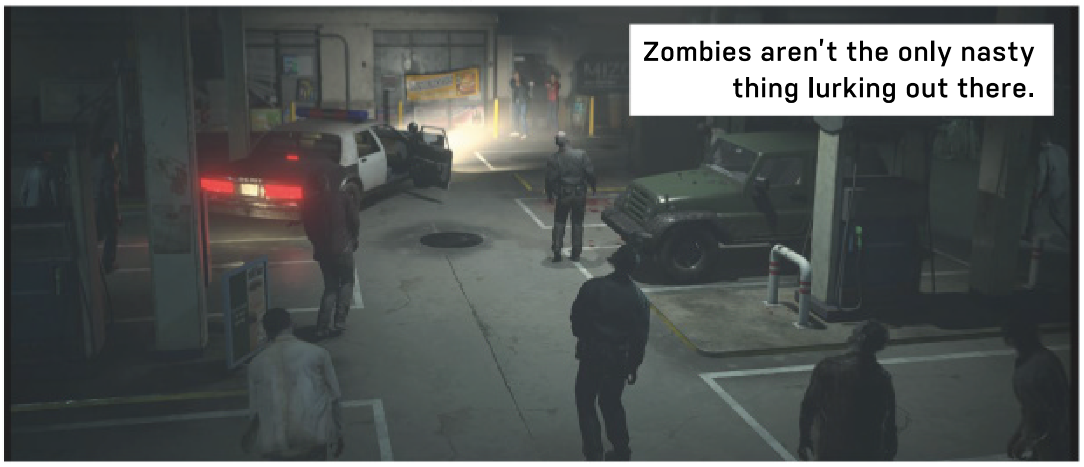
RECOMMENDED SPECS Pentium 2GHz or AMD equivalent; 4GB RAM.

$25, www.failbettergames.com, ESRB: Not rated


The new camera angle improves things immensely.


If you're grabbed, it's a fight for your life.

Leon seems unconcerned by dangling intestines.


Zombies aren't the only nasty thing lurking out there.

Resident Evil 2

A quick-shooting zombie thriller requiring braaaains

WELCOME TO 1999, we hope you like your PlayStation. The fashion for remaking old games delivers a solid hit here, enhancing the original while staying true to what made it a success 20 years ago.

And a lot has changed in that time. *Resident Evil 2* made you struggle against the game itself as much as its zombies, with unruly controls and a save system that revealed the terror of lost progress to be as much of a motivator as the threat of the living dead chewing your jawbone off.

So, while this new game adopts the over-the-shoulder camera perspective that arrived with *Resident Evil 4*, and throws off the pre-rendered backgrounds, it retains the save system that has you hunting out typewriters, along with the limited inventory and occasionally baffling herb-based health potions of the original.

The new engine, which powered *Resident Evil 7*, reveals Capcom to be a master at hiding nasty things in places you wouldn't expect. The removal of the fixed camera angles that made it easy to place a bad guy around a corner, out of sight, means the developers have had to be sneakier, playing with lighting tricks and clouds of smoke in ways 20-year-old games can't usually think of. To this end, there has been some rearrangement of the levels, weapons, and monsters.

A big change is the Tyrant, or Mr X. He's still big and mean, and stalks you from room to room, breaking the accepted rules of the game as he does so. He also homes in on your gunfire, making self-defense dangerous. He always seems to be near something you need. He's immune to anything except being stunned with a flashbang, and his punch does a lot of damage. Now that you're not fighting the controls as much, the cannon-fodder zombies are tougher, too, and a neat mechanic sees you boarding up broken windows to prevent more pouring inside.

Ammunition is still scarce, so zombie-avoidance is a strategy that needs to be perfected, and just like the original, *Resident Evil 2* hides a puzzle game beneath its guns-'n'-guts survival-horror exterior. There are codes to be broken, items to be combined, rooms to be visited, and items to be found. There's a new "assisted" difficulty that tries to take the edge off the horror, and let you get on with the business of shooting zombies, but all this does is underline how close the game and its systems were in the original. You're meant to be stressed out about the location of the nearest typewriter, and where to find some shotgun shells, because at that moment, the game will drop something huge and fleshy on you.

Resident Evil 2 now plays the way you remember it. Picking up the original today is an exercise in frustration—stepping back 20 years in game design is like getting into a 1999 Chevrolet when you're used to a Tesla. But when games are updated with as much care and attention to detail as this, we're happy to explore Raccoon City one more time. **–IAN EVENDEN**

VERDICT **8**

Resident Evil 2

+ **UNDEAD** Great-looking, heavily modernized remake of a classic.

− **BLOODSHED** Stressful, especially the save system; not for the faint-hearted.

RECOMMENDED SPECS i7-3770 or FX-9590; 8GB RAM; GTX 1060 or RX 480 (3GB VRAM).

$60, www.residentevil2.com, ESRB: M

LAB NOTES

BO MOORE, HARDWARE LEAD

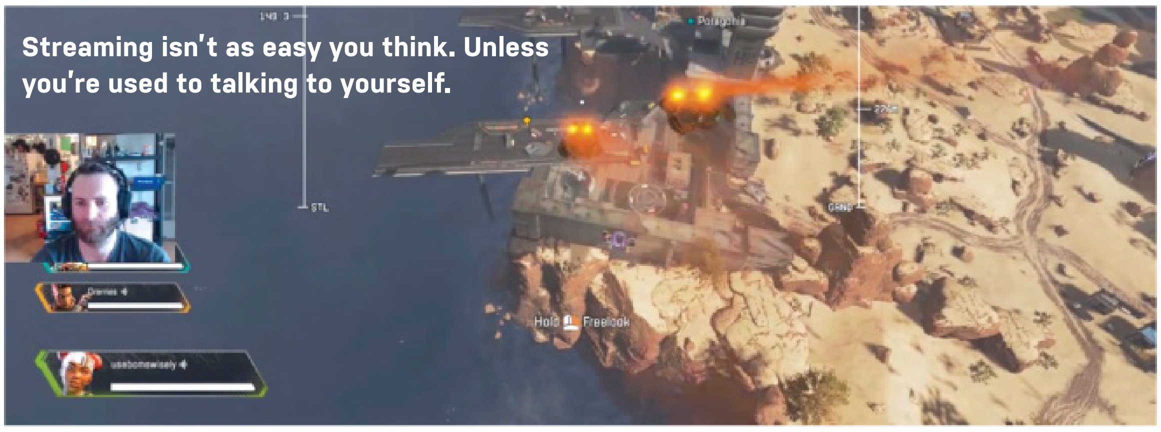
Baby's First Live Stream

Tales from my first time streaming alone on Twitch

AS I WRITE THIS, I've just finished my first ever solo Twitch live stream. Our normal PC Gamer Show host James had his power knocked out, so I hopped in last minute.

First off, let me just say that streaming is weird. I've always had an admiration for folks who can sit and play the same game for hours on end, day after day. But more than that, after experiencing it myself, I'm impressed at the streamers who can effectively keep up a conversation with themselves while performing in-game at a high level. Even more impressive are the ones who can read Twitch chat and hold a conversation with their viewers, while still landing headshots. It's an acquired skill.

But back to my brief streaming experience. Things started rough—the pressure of people watching my gameplay definitely messed me up in our first few firefights. But after getting over the jitters of having some 2,000 folks watching me miss my shots in *Apex Legends*, I started to get into a rhythm. I had a few good rounds, and even finished top-two with a squad of random teammates, which is quite the success any way you look at it. I certainly don't have any desire to pursue a career in game streaming, but now I at least know how to get things running if I'm up for sharing a session here and there. It's surprisingly easy to get set up, too. Sure, you can go all-in and invest in studio lighting and a high-end mic, but to get started, all you really need is a decent webcam and gaming headset.


Streaming isn't as easy you think. Unless you're used to talking to yourself.

JOANNA NELIUS

Hardware Staff Writer

Back in December, I started building a new gaming desktop PC, but between taking a trip to Boston and attending CES, things happened—my apartment ate a crucial cable needed to power my liquid-cooling pump. My new rig sat in my living room for two months, then I finally got a new cable and finished building my PC after cursing my way through the cable management.

But this is a story about my old rig, the one I built while I was working a dead-end job, attending graduate school, running two literary magazines, and writing freelance game reviews—all while trying to keep my sanity intact. I used my old rig for everything, such as writing my MFA thesis and learning to stream on Twitch. I played several of my favorite games on it for the first time. That rig stuck with me through two breakups, two job changes, two deaths in the family, and when I moved six times in two years.

It's interesting how material possessions can come to symbolize the beginning or end of a stage in our lives. Maybe that's why I have a ridiculous amount of RGB lighting in my new rig—this is the colorful beginning of a whole new stage in my life. So, thank you, my trusty AMD FX-6300 build. I hope you bring just as much joy to the next person who uses you.

Editors' Picks:
Digital Discoveries

Senior editor, Jarred Walton, and executive editor, Alan Dexter, have been throwing pixels at screens

GEFORCE GTX 1660 TI

Wait, a new GeForce GTX card—what is this, 2017? No, it's Nvidia backpedaling on ray tracing and deep learning, sort of. We'll have the full review next month, but in short, performance is good, and pricing is finally in that sub-$300 sweet spot mainstream gamers go for. It basically equals the performance of a GTX 1070, and with that card discontinued and supplies drying up, the GTX 1660 Ti takes its place and saves you money.

If you've been feeling less than enthusiastic about Nvidia's RTX line, send the company a message that you don't care about ray tracing or DLSS by opting for this trimmed-down TU116-based GPU instead. Then sit tight and wait for the technology to mature, and when the inevitable next-generation Ampere parts show up in a year or so, maybe then it will be time to upgrade to something more potent.

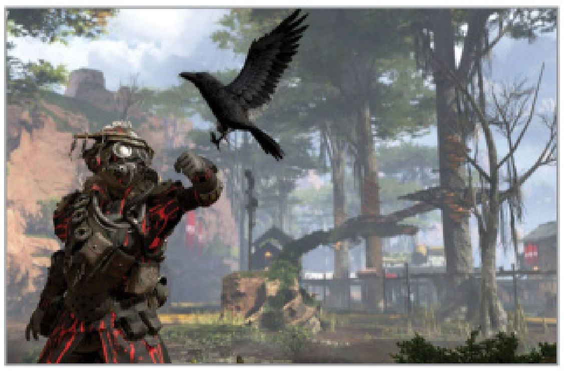
Or not. Let's face it, 1080p ultra is still great, and it's the games that matter, not a higher resolution or slightly improved image quality. If you've been hanging on to an old GTX 700 or AMD R9 series GPU (or anything older), the GTX 1660 Ti can give a substantial boost in performance, while reducing power use. Time to upgrade.
$280, www.nvidia.com

APEX LEGENDS

Just when you thought Battle Royale had run its course, along comes EA with a fresh take on the genre, with *Apex Legends.* It's been a huge hit, quickly jostling for the top spot on Twitch. There are a few reasons for this, not least of which is that it doesn't cost a penny to get in there and see what all the fuss is about.

If you've sampled the likes of *PUBG* and *Fortnite,* it's largely familiar territory: 60 players, in groups of three, are dropped on to a large, varied island, with the explicit intention of murdering the other 19 teams. Weapons, upgrades, armor, and their like are scattered around, and the first moments of any battle are a desperate race to grab decent gear while trying to avoid anyone who has landed mere seconds before you.

It's a good-looking game, and there's a surprising amount of depth afforded by the eight characters that all play differently. The big selling point is the focusing system, which enables you to communicate easily with the rest of your team, highlighting enemies, weapons, and areas of interest with a single click that is intuitive and accessible for all, without requiring a microphone. Grab it on Origin today.
Free, www.ea.com



Goliathus Mobile Stealth Edition

LET'S GET THE OBVIOUS out of the way first: This is a mouse mat. Nothing ridiculous, just a mat on which to slide your trusty rodent around. It isn't a particularly clever one, either, shunning the current trend of being an inflexible solid surface, and also lacking a wealth of RGBs to warrant a ridiculous price tag. Indeed, a quick look at the bottom of this column will reveal that it'll set you back just $8. It's a focused piece of gear, though, aimed at serious gamers on the go.

Despite its ridiculous name, the Goliathus is tiny. Indeed, at 1.5mm, it's thin enough to slip between the keyboard and screen of your laptop, or failing that, you can roll it up, slip it in your bag, and barely notice it's there. At just over 8 inches by 10 inches, it provides a reasonable amount of room for normal sensitivities, and the textured top surface gives plenty of control for those who like to hide out of the way and snipe players from insane distances.

What's it like to use? Not bad at all. The rubber bottom does a good job of holding itself in place, while the top surface is comfortable to work on and can get you out of a jam on a rough table. It's absolutely a solution for a niche market—do you really need a portable mouse pad? But, if you do, it gets the nod from us. **–AD**
$8, www.razer.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Superb Soundcards
> Quality Keyboards
> Missing SGX

Sound Advice

I read Zak Storey's response to Rick Breckwoldt's question regarding a low-distortion, high-quality soundcard. Technically, Zak was correct, but motherboard sound is only OK to those raised on compressed music; it ain't hi-fi.

There is the Asus Essence STX II PCIe soundcard (also labeled as the Asus Xonar Essence STX II PCIe soundcard). This is a very high quality soundcard. I use it (with Virtins Multi-Instrument software) for calibrating distortion analyzers, sound level meters, and other audio-related testing. It's also produced beautiful, true audio sound, from my homemade vinyl-to-digital recordings (96KHz sampling/24-bit) through my old homemade (12-inch DeForrest woofer/5-inch Altec 411 mid/1-inch JBL Compression horn) ear-bangers. Asus's 10-band equalizer control software is pretty much up there for playback adjustments, too.

The Asus soundcard's inherent distortion is extremely low, has line level I/O, and, more to the point, it has L/R RCA output as well as 1/4-inch stereo phono line level I/O. All of which I believe fits his I/O needs. **–Tom Woroby**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: There are still a few soundcards doing the rounds—EVGA recently entered the fray with its Nu Audio card—but it's a shrinking market, and it isn't hard to see why: The audio offered by most modern motherboards is good enough for the vast majority of what people want to listen to.

Having said that, there's a lot of love for the Asus card you mention (not just from yourself). Even so, it's hard to justify dropping $350 on a dedicated card if you spend most of your time listening to YouTube videos, your own music collection, and the like. Maybe we need to take a look at what the options are for audio hardware in a future issue, and put this to bed once and for all. In the meantime, if anyone is underwhelmed by their audio solution and has some spare cash, the Asus card is worth tracking down.

Ghost in the Machine

I'd like to see the mag discuss the new Intel and AMD chips coming out with respect to Meltdown and Spectre. Right now, Meltdown and Spectre require OS-level fixes that can kill performance under certain workloads. Do the new chips address these vulnerabilities so they don't have to be handled by the kernel? Can the workarounds for these vulnerabilities be disabled on new chips to get our pre-Meltdown/Spectre performance back?

–Scott Moore

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: This is something we've had on the cards for a while, but we're waiting to see what the next generation of chips offers, as at the moment, we're just seeing a lot of patches and tweaks in response to the never-ending variants of the exploits. These patches aren't just on the OS level, with BIOS-level fixes in the mix as well. We've seen performance hits on our test bench, particularly for Intel's chips, although the impact this has from one patch to another is difficult to pin down.

Google published a paper recently stating that the variants of the Spectre vulnerability may be impossible to fully protect against with software patches alone. It could require a fundamental change to the way that processors work. As you can imagine, that would take some time to filter through to consumer chips.

Will we ever see performance back to where we were before the vulnerabilities were discovered? Possibly, but I think we can expect more pain before it gets better.

Keyboard Choices

I have been a subscriber for over 15 years. After reading each issue, I keep a couple of recent ones handy, but generally recycle older issues. I have a surprise need to buy a new keyboard, as my wife does not like my old Microsoft ergonomic model. I recall a recent keyboard review that had a rating of a nine. I looked online (I am aware that your website is PCGamer.com), and Wikipedia states

↘ submit your questions to: comments@maximumpc.com that effective July 2018, *Maximum PC* reviews can no longer be found on this site under Hardware. I have a print-only version—do I need digital to see older reviews? **–Bill Lutter**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: We cover the best hardware from the last 12 months in our "Gear of the Year" feature, which was last printed in our Holiday 2018 issue. In that roundup, we had two keyboards that scored highly, with the Roccat Vulcan 120 ($160) and Wooting One ($140) getting the nod. We also gave the HyperX Alloy Elite RGB a nine, so that's worth keeping an eye out for.

Plenty of our reviews do make it online after the issue is off sale, and there's also a roundup of the best keyboards at www.pcgamer.com/best-gaming-keyboard, although there's an obvious gaming bent to that list.

Processor Efficiency

In the June 2018 issue, you compare the Ryzen 7 1800X and Ryzen 7 2700X, which gave an 11 percent processing power increase to the 2700X. Energy-wise it's not such a great deal, with a 19 percent increase. Seems AMD isn't hitting the efficiency button very hard. What may be a mitigating circumstance is the price to performance increase, of around 10 percent. Does Intel do better?

–Murray McCullough

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: It probably won't surprise you to learn that this is a complicated issue, and one that highlights some of the choices chip builders make when designing the full family. For instance, efficiency is less of a focus at the top of the stack, where performance is vital, while more budget-oriented chips can do incredibly well. For example, the power draw of Intel's Xeon W-3175X is nearly 400W under load, while a Ryzen 2700X stays under 120W. Overclock the aforementioned Xeon, and you can see its power draw more than double—so if efficiency is important, overclocking probably isn't a good use of your time.

Broken 4K on Intel

After running an Intel Core i7-5930K on an X99 motherboard for years, I had intended to build an Intel X299 system. Then I discovered that Intel has pulled the SGX (Software Guard Extensions) instruction set from all LGA2066 CPUs. Ironically, Intel's mainstream CPUs continue to support SGX, but the HEDT platform can't play the most common sources of protected 4K video, such as Netflix streams and Blu-ray discs.

This is a deal-breaker for many, yet I can't recall any discussion in *Maximum PC.* Surely, this was relevant to your "Optimal 4K Playback" article in November 2018? How about your review of the Intel Core i9-9980XE (February 2019), which praises the chip for its AVX512 instructions but doesn't ding it for missing SGX? Shouldn't a processor costing over $2,000 be able to play Netflix?

What workarounds or upcoming technologies may replace SGX or remove the need for it? Do AMD Threadripper processors have similar shortcomings? Will Intel address this with future HEDT products, such as X599 or rumored Z399 chipsets? If this is not widely discussed in technology publications, it seems unlikely Intel and others will devote their attention to addressing the issue in future products.

–Charles W. Booth

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: You're absolutely right about the lack of SGX in some of Intel's high-end chips, and we admit to not spotting this when we looked at them. It's certainly worth bearing in mind if you're looking to build a machine for watching Blu-rays.

Farewell to Zak

I sincerely hope that Zak is moving on to bigger and better things, and wasn't canned for expressing a bit of reasoned humanity. I understand that some want to read only what they pay to read—fair enough. Even so, the depth of anger expressed over the slightest thoughtful expression eludes me. A little glimpse of the people behind the technology is important to me, and a major reason I subscribe.

Allow me to explain. I am an old geezer pushing 80. While I am amazed at the number of knowledgeable readers you have in that age bracket, I'm severely tech challenged. For example, I took a couple of your Geek Quizzes, and my all-time best was three correct answers. And I cheated to get two of them, and wrote my name at the top of the page to claim credit for the third. I subscribe to *Maximum PC* in a mostly futile effort to stay abreast of things.

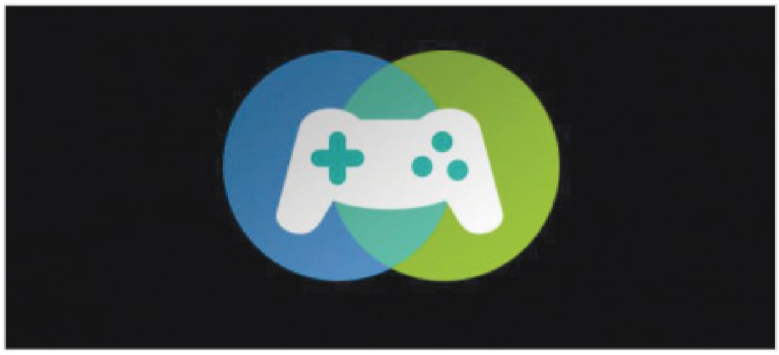
I don't recall how I stumbled on to *Maximum PC,* but it was the human face some of your predecessors gave the magazine that tempted me to subscribe. I enjoyed reading about your work, and about you. I wish only the very best for Zak; I will miss you a great deal, and I sincerely thank you for helping me in my mission.

–Jim

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Don't worry, Zak wasn't pushed, he jumped at the chance to work on Tom's Hardware. As I'm sure you've spotted, Zak is still helping put the magazine together, too, so a win for all of us so far.

[NOW ONLINE]

HOW TO SHARE YOUR PC GAME LIBRARY WITH THE REST OF YOUR FAMILY



From Steam to Origin, which services let you share your library with family and friends?

Remember the old days, when you could just go grab a *SimCity* CD-ROM out of your older brother's room to play on your own PC, then take it over to your friend's house, and show him how awesome it was? Afterward, his mom took you and your best bud to hang out at the mall, and you bought more games, and forgot all about *SimCity.* That is, until your brother realized it was missing, and what followed turned into a very unpleasant experience....

Read the full article: https://bit.ly/2VmQTum

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THE BUILDS

BUDGET

INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$55
PSU	450W EVGA 450 BR 80+ Bronze	$30
Mobo	ASRock AB350M Pro4 AM4 **NEW**	$65
CPU	AMD Ryzen 5 2600	$170
GPU	Zotac GeForce GTX 1060 3GB **NEW**	$212
RAM	8GB (2x 4GB) Patriot Viper 4 @ 3,000MT/s	$58
SSD	120GB ADATA Ultimate SU650 2.5-inch SSD	$25
HDD	1TB Western Digital RE3 3.5-inch HDD	$38
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit	$16

Approximate Price: $669

LAST ISSUE, WE MANAGED to shave a few dollars off this build and still end up with a decent budget machine. This month, it's a different story. Price increases big and small have meant that we've seen the overall cost jump up $37, while the underlying performance and capabilities haven't really changed in any notable way. Even hitting this price point, we had to say goodbye to a couple of components. The ASRock motherboard we used last month saw a significant price hike, which forced us to switch to the ASRock B350M Pro4 AM4. Meanwhile, the diminishing stock of GeForce GTX 1060s means that we had to swap out from last month's Gigabyte card to the Zotac, because the former saw a $60 price increase. Gulp. There are rumors that GeForce GTX 1660 and 1650s are on the way, which should really help our budget build, because we can't see this trend reversing anytime soon.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$90
PSU	550W Corsair CX500M 80+ Bronze **NEW**	$60
Mobo	Asus ROG Strix B450-F Gaming	$130
CPU	AMD Ryzen 7 2700	$250
Cooler	Corsair Hydro H100i Pro 240mm RGB AIO	$110
GPU	EVGA GeForce RTX 2060 XC Black 6GB **NEW**	$350
RAM	16GB (2x 8GB) G.Skill Aegis @ 3,000MT/s	$90
SSD	250GB Samsung 970 Evo M.2 PCIe SSD	$96
HDD	1TB Western Digital RE3 3.5-inch HDD	$38
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,314

OVERALL, WE'VE SEEN a slight saving on this build this month, because most of the parts used were roughly in the same ballpark as they were last month. The one exception to this was the power supply, with the EVGA SuperNOVA jumping almost 50 percent compared to what we paid last time. That's why we swapped it out for the Corsair model, which may only be Bronze rated, as opposed to the Gold of the previous unit, but it still has the same wattage, and is semi-modular as well. Elsewhere, we saw a $10 saving on the CPU, along with a $5 saving on the RAM. The graphics card we used last month jumped up $20 in price, so we replaced it with this tiny EVGA model, which is still available at $350. Despite reports of oversupply of graphics cards for both AMD and Nvidia, pricing on individual models remains volatile, so shop around, and don't be tied to a specific card if you can help it.

TURBO

UPGRADE OF THE MONTH

ASUS TURBO GEFORCE RTX 2080

It's a busy time for graphics cards—new GPUs are coming thick and fast, and the GeForce GTX 1660 Ti is on the way, too. Trying to pick a winner isn't easy, especially when the case for the RTX family in general has yet to be convincingly made. Even so, when it comes to our Turbo build, there's only one card that really makes sense for the money: the GeForce RTX 2080. While there is more performance to be had from factory overclocked models, it's the stock clocked cards that make most sense in terms of value for money. So, this Asus card may not fill your case with cool looks, but it delivers where it counts the most—performance. **$710, www.asus.com**

THERE ARE NO significant changes to the Turbo build this month, with only the graphics card differing from last month's parts list. That was due to a price increase for MSI's card, which jumped by $20. That isn't much in the greater scheme of things, but when the same performance is available for less elsewhere, we really don't see the point in sticking with a specific card. In fact, the card we ended up with, the Asus Turbo GeForce RTX 2080, is $10 cheaper again, so overall we're making a saving already. Obviously, at this end of the spectrum, that isn't a lot of money, relatively speaking, but as we're not in the realms of factory overclocked cards anyway, there's no real difference to be had.

There were a couple of small savings to be had with other components: The ASRock motherboard was $10 cheaper, and we saw the same saving on the AMD Threadripper 2950X—as the processor war rolls on, our pockets appear to be the victors for now. These savings were offset slightly by a $10 increase in the price of the memory kit we use, although given the general sensitivity to RAM, this seems like a reasonable price to pay. Overall, this machine is $20 cheaper than last month, for exactly the same performance. Not much of a saving, but welcome all the same. And until we're hit with some new architectures from Intel and/or AMD, this is still the best overall solution for serious work in our minds.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	NZXT H700i		$180
PSU	Corsair RM750x White 750W Gold Certified		$120
Mobo	ASRock X399 Phantom Gaming 6		$240
CPU	AMD Threadripper 2950X		$870
Cooler	Noctua NH-U14S TR4-SP3 Air Tower		$80
GPU	Asus Turbo GeForce RTX 2080	**NEW**	$710
RAM	32GB (4x 8GB) Corsair Vengeance LED DDR4 @ 3,000MT/s		$248
SSD	512GB Samsung 970 Pro M.2 NVMe		$168
HDD	2x 2TB Seagate BarraCuda ST2000DM006		$120
OS	Windows 10 Home 64-bit OEM		$100
Approximate Price:			**$2,836**

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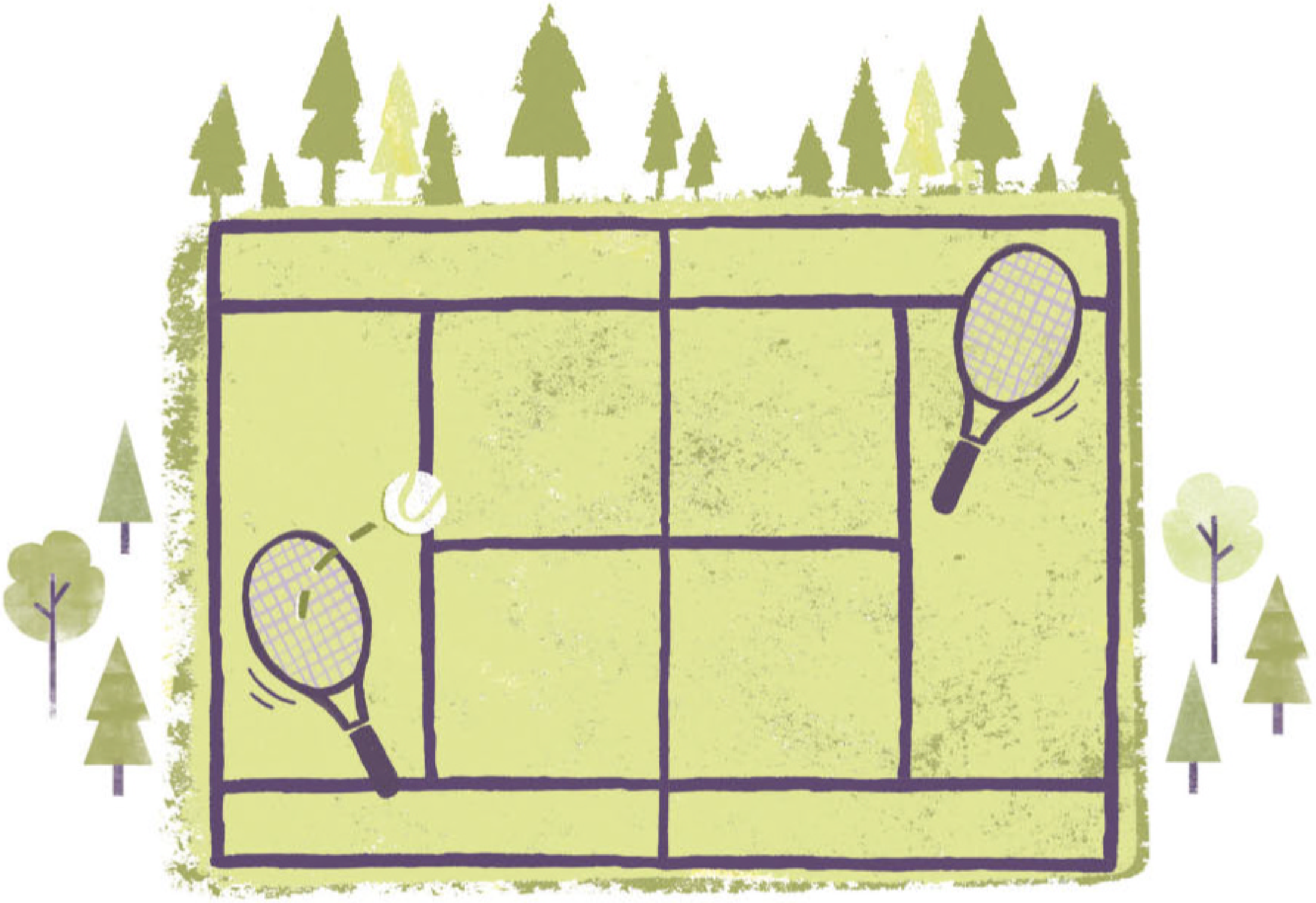

Did you know that U.S. forests, which provide wood for making paper and many other products, have been growing every day, equal in area to more than 22,000 tennis courts!

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UNFAO, Global Forest Resources Assessment 2005-2015

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